difficulty and to produce an accurate record of rates. It was discovered that a slight blow upon the pen arm *C* of the instrument produced a perfectly legible tick, or dash, upon the record, and after that the solution was comparatively simple.

Working under suggestions from the writer, Schneider Brothers, of Jersey City, N. J., made a striking arm actuated by clockwork, which was installed in the case of the Draper gage, as shown in Fig. 1. At the left end of the striking arm *D*, but concealed by it in the illustration, is the hammer. The holes in this arm provide a variable location for a balance weight *E*, which regulates the blow, and the pawl *F*, bearing upon a ratchet wheel, raises this striking arm and hammer as the wheel revolves. At the upper limit of its movement the pawl drops off the tooth of the ratchet and the hammer in falling gives a slight blow upon the pen arm *C* of the rain gage.

The ratchet wheel revolves once in 12 min. and has six teeth, thus producing a blow of the hammer once in two minutes. The time between hammer strokes can be regulated by substituting a wheel having the proper number of teeth to produce the desired interval. A wheel with 12 teeth, giving a blow once each minute, was first tried, but the marks on the record were found to be nearer together than was necessary and therefore the time interval was increased to 2 min. by substituting a wheel with half the number of teeth.

Fig. 2 is a reproduction of a chart made by this instrument. An inspection of the chart will show how easily and accurately the rates of precipitation of the storm recorded may be determined.* Where the marks produced by the action of the hammer are so close together as to be uncertain in number, or indistinguishable, the rates of precipitation are less than 0.1 in. per hr. and are of no value for the record desired. All rates of any importance may be determined easily from these charts.

*Unfortunately, the dots on the original were so small that they do not show in the reproduction.—Editor.

In the original of Fig. 2 it could be readily seen that the maximum precipitation occurred between 5:30 and 6:15 p.m. As the space between any two horizontal lines on the chart represents 0.01 in. of rainfall, counting the number of such spaces between any two consecutive marks made by the hammer and multiplying this number by 30 will give the rate of precipitation, in hundredths of an inch per hour, for a period of 2 min. Counting the number of spaces between any three consecutive marks and multiplying by 15 will give the rate in hundredths of an inch per hour, which lasted for 4 min., and, similarly, the number of horizontal spaces between any of the marks produced by the hammer multiplied by 60 and divided by the number of minutes indicated by the hammer markings over the space under consideration will give the corresponding rate of precipitation in hundredths of an inch per hour for the period covered.

From the foregoing statements it is evident that an accurate interpretation of rates per hour can be readily determined for any length of time desired, and that such interpretation does not depend on any scaling of lines upon the chart, but can be read directly from the same.

FIG. 2. PAWTUCKET RAINFALL CHART, SHOWING RAINFALL RATES

The ruled face of the original chart is 5x12¾ in., and is much more easily read than is this reproduction

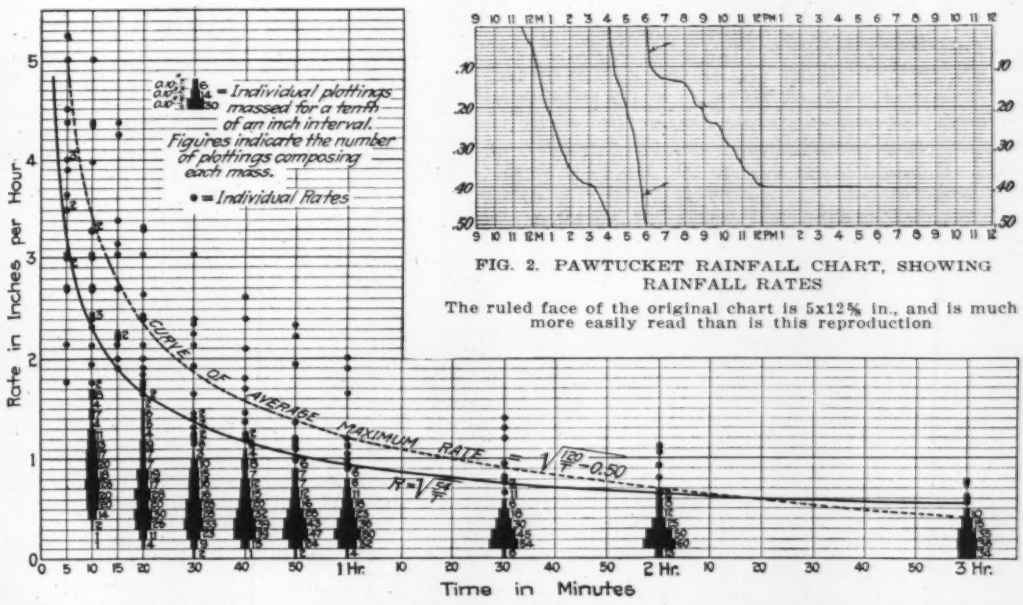

= Individual plottings massed for a tenth of an inch interval. Figures indicate the number of plottings composing each mass.
= Individual Rates
CURVE OF AVERAGE MAXIMUM RATE
Rate in Inches per Hour
Time in Minutes
1 Hr.
2 Hr.
3 Hr.

FIG. 3. RATES OF RAINFALL AT PAWTUCKET, R. I., JANUARY, 1902, TO JANUARY, 1912

A practical application of the data thus obtained is illustrated in the rainfall curve shown in Fig. 3. After determining rates of precipitation for intervals of 5, 10, 15, 20, etc., minutes for a period of years, these data are plotted as shown by the black dots of Fig. 3. Where these dots become so numerous as to be indistinguishable as to number, the expedient has been adopted of representing them by the *volume* of the area made solid black and by indicating the number of the dots by a figure placed opposite each black space.

The rates plotted in Fig. 3 cover all the storms of the ten-year period from January, 1902, to January, 1912, which had rates of precipitation of 0.75 in. per hr. or more. The arbitrary "curve of average maximum rate" was obtained by averaging the maximum rates of each year.

Automatic Block Signals on an Interurban Railway

The Oakland, Antioch & Eastern Ry. is an interurban electric line between Oakland and Sacramento, Calif., 85 miles long. The nine miles between the Oakland station and San Francisco is covered by running over the San Francisco & Oakland Terminal Ry. to that company's pier, where passengers are transferred to the ferry

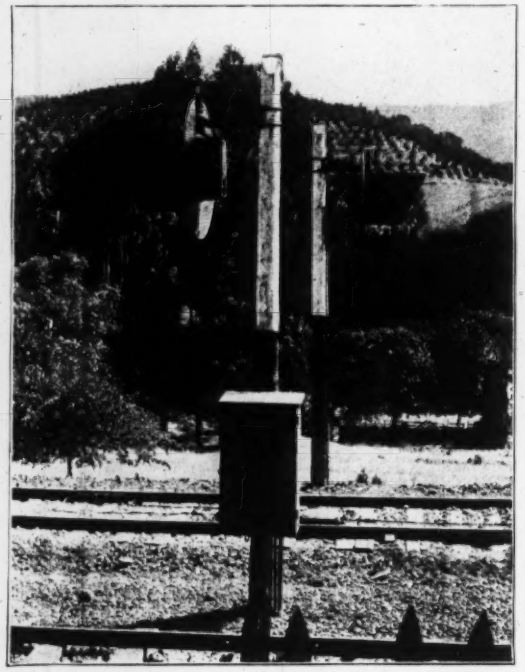


FIG. 1. ELECTRIC-LIGHT ALTERNATING-CURRENT AUTOMATIC BLOCK SIGNALS ON THE OAKLAND, ANTIOCH & EASTERN RY.

steamers. The road has a single track. Passing sidings, the majority of which are single-ended, are one to six miles apart. Substations 16 to 22 miles apart receive 60-cycle current from the hydro-electric plant of the Great Western Power Co.; one receives it at 22,000 volts, the others at 11,000. The substations deliver 1200-volt direct current for propulsion and 2200-volt, 60-cycle alternating current for the signal system.

As the line passes through much country in which traffic will be comparatively light for some years to come, it was desirable to keep the initial investment down to a minimum. In the signal system economy in construction has been combined with safety in operation.

Block-Signal System

The block-signal system consists of center-fed track circuits extending between pairs of home signals located at sidings, each home signal having its distant signal serving as a repeater. Track circuits were not allowed to exceed 7000 ft. in length. When the distance between sidings is greater than this, it is divided into two or more track circuits, all alike as to apparatus and arrangement. When the distance between sidings is greater than that desired between the home signals, intermediate pairs of home signals (with their respective distant signals) are installed, the apparatus being the same as at sidings except for the absence of the switch indicator. There are 42 blocks (averaging two miles in length) and [illegible] track sections for the 85 miles of line.

The signals are of the electric-light type, shown in Fig. 1, no semaphores being used. This has the advantage of eliminating all moving parts, and is therefore less liable to interruptions of service caused by the signal's getting out of order. It is very much cheaper, consisting of only two lamps in a hood designed to make them distinctly visible by day as well as by night (*Engineering News*, Dec. 24, 1914). The home signals are in pairs, as shown in Fig. 1, with a single distant signal in each direction. The box on the nearer pole contains the control apparatus, which consists of two line relays on an upper shelf and two galvanometer-type track relays below.

Each home signal gives red and green indications. The distant signal is located 1000 to 2000 ft. from the home signal and gives yellow and green indications. The yellow light shows at the same time as the red light of the home signal, giving the motorman ample time to get his train under control so as not to overrun the home signal if the latter still shows red when he reaches it. Fig. 2 shows a single-end siding, with the two home signals placed at the fouling point.

Opposing trains may approach each other to a common point at a pair of home signals, but each will have been forewarned by the distant signal. Thus opposing trains do not run blindly up to a pair of home signals indicating "stop" without previous warning of their position. A simple form of switch indicator is used, shown at the left in Fig. 2. This has only a green light. When the light does not show, the switchman must not open the switch to allow a train to leave the siding. The signal equipment was furnished by the Union Switch & Signal Co., of Pittsburgh, Penn., and includes 83 home and 84 distant signals.

Details of Circuits

Fig. 3 shows the circuits for a typical block consisting of one track circuit. When the block length is such as to require two track circuits, the additional connections shown by the smaller diagram (at the right) are introduced in the middle of the block. It should be noted that the impedance bond permits the direct current for propulsion to flow without interruption past the insulating rail joints, but is practically a barrier against the flow of alternating current between two track circuits or between the two rails of one track circuit. In tracing

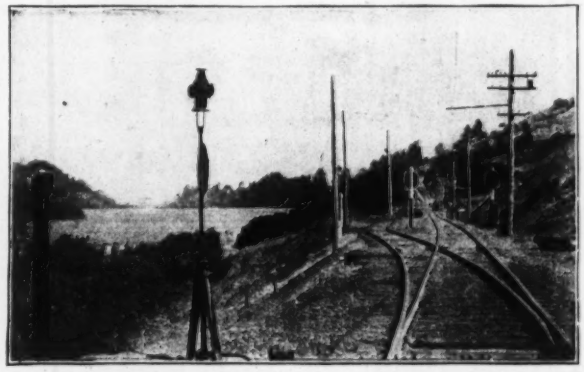


FIG. 2. SIGNALS AT PASSING SIDING
Home signals at the fouling point and indicator to the left of the switchstand

the signal circuits on the diagram the rails and track circuits should be considered as insulated from each other at insulating joints.

All track circuits are center-fed, having a galvanometer relay at each end. It will be seen by Fig. 3 that the control circuit of a block is carried through the track relay at the adjacent end of the next track circuit east of the block. This is done to secure a preliminary indication and obviate the possibility of two trains entering the block at opposite ends and meeting in the middle.

When a westbound train enters the track circuit just east of the block under consideration, the track relay at the west end of that track circuit is not operated at once, but when the train has advanced through about one-fourth of the track circuit the resistance of the rails between the train and the track transformer has fallen so low as to short-circuit the track relay, and the signals at the west end of the block are set to danger. If an opposing train has already entered this block, the two trains will be protected by the distant signals, as noted.

By this arrangement the necessary amount of alternating-current track-circuit equipment is reduced to a minimum. Line relays control the indications of the home and distant signals and of the switch indicators. Switch-circuit controllers are applied to the siding and other switches to give the necessary protection when a train is entering or leaving a siding or when a switch is left open for any other reason or through carelessness.

Two No. 6 bare copper wires extend the length of the signal system, carrying the 2200-volt alternating current. There are three No. 10 weatherproof copper line wires for the signal-control circuits and two additional similar wires extending from the home to the distant signals. The wires are all carried on the upper crossarm (Fig. 2), the five line wires on the left-hand side of the pole and the two 2200-volt mains on the right. A line transformer is also shown on the pole, connected to the 2200-volt mains and supported beneath them.

In the initial installation it was desired to avoid the expense of standard switch indicators and control wires. An effective substitute arrangement was provided by installing at the east end of double-end sidings and at the switches of single-end sidings electric-light indicators controlled by the adjacent signal-control apparatus. The indicator is shown at the left in Fig. 2.

The pair of home signals is located between the ends of double-end sidings. At a single-end siding with switch pointing to the west the home signals are west of the switch; where the switch points to the east they are at the fouling points (as in Fig. 2). With the indicator circuit as shown in Fig. 3 and with the location of signals as described, preliminary protection is given the indicator from each direction without the use of line wires and without sacrifice of safety.

At a double-end siding, cars must leave by the east end only, and the switchman must note that the indicator shows green as he opens the switch. On leaving the siding, an eastbound train proceeds without observing the home signal at that location, the signal indication having been duplicated in the switch indicator. A westbound train observes the indication of the home signal and thereby secures preliminary protection. These conditions apply also for movement out of a single-end siding with its switch pointing east.

When leaving a single-end siding with switch pointing west, the switch indicator is observed in the same manner and the proper home signal is observed before proceeding either west or east. For proceeding out of a siding of this class when the indicator shows green, preliminary protection between this movement and an approaching eastbound train is given by the time interval between the opening of the switch and the moment when the train reaches the westbound home signal, having covered the distance between the fouling point and the signal. This operation, being necessarily slow, occupies a period of time during which a train moving at high speed on the main track covers a comparatively long distance. Thus, as long as the signals and switch indicators are observed there can be no collision.

One point of objection is the time lost by an eastbound train waiting on a siding for a passing westbound train to travel the length of a block in order that the switch indicator may show green. This is not serious under the present conditions of light traffic. When increased traffic demands the elimination of this delay, a switch-indicator wire can be run the length of the block and two indicators (one for each direction) placed at each switch.

The reason for not leaving a double-end siding at the west end is that such a move could not be protected by a switch indicator without running an additional wire, because no preliminary protection would here be available, as at the east end.

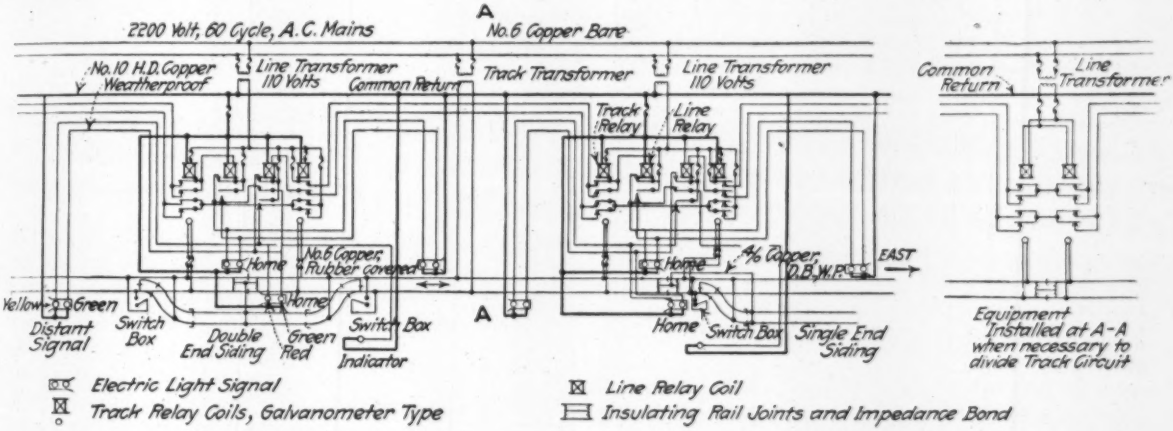


FIG. 3. DIAGRAM OF CIRCUITS FOR THE BLOCK-SIGNAL SYSTEM OF THE OAKLAND, ANTIOCH & EASTERN RY.

The April Floods in Texas*

By B. Bunnemeyer†

The floods that occurred in Texas during the last ten days of April, 1915, and the greater part of May, while far from approaching the severity of the record-breaking floods of December, 1913, are memorable from the fact that they caused a loss of 40 lives and an indeterminable, but immense, damage to crops. The latter had to be replanted not only in the flooded area but also in sections where the soil had been washed by heavy rains. Incomplete returns give an estimated damage of $2,354,125 (exclusive of losses sustained by railroad, telegraph and telephone companies), classified as follows:

	Watersheds				
	Colorado	Brazos	Trinity	Guadalupe	Total
County bridges, roads, buildings, etc.	$650,750	$159,900	$15,400	$500	$915,425
Crops	5,250	1,324,000	6,000	6,500	1,341,750
Live stock	..	68,825	..	..	68,825
Suspension of business	..	102,500	10,000	4,500	117,000
Total	$656,000	$1,655,225	$31,400	$11,500	$2,423,000

The deaths occurred in the creeks, which were rapidly converted into raging torrents by the heavy rains and caught the people unawares. Of the 40 deaths, perhaps 8 could have been prevented by the exercise of a little caution.

Considerably over one-half of the total damage reported was due to loss of crops in the field; over one-third consisted of damage to buildings, bridges and roads, mostly in the city of Austin; and the remainder (less than one-twelfth) represents losses by suspension of business and drowning of live stock. Railroads suffered considerably from washouts and interruption of traffic.

From Apr. 14 to 20, 1915, a series of local showers occurred over the Guadalupe, Colorado, Brazos and Trinity watersheds, which became sufficiently cumulative to justify the issuance of warnings on Apr. 20 for the Guadalupe and lower Colorado. Most of this water soaked into the ground and no dangerous rises occurred. On Apr. 21 the precipitation was too light to affect the streams, but on the 22nd unusually heavy showers set in, which were reported on the morning of Apr. 23 and resulted in an immediate issuance of flood warnings for the Guadalupe, middle and lower Colorado, middle and lower Brazos and upper Trinity.

Colorado River Flood

The Colorado River began to assume a serious stage all along its course during the night of Apr. 22 and 23. A heavy rain set in at Austin about 7:45 p.m., and by midnight as much as 8 in. of water had fallen. The rain converted Waller and Shoal Creeks into raging torrents, and the flood damage and loss of life at Austin were almost entirely due to the overflows of these creeks. Shoal Creek empties into the Colorado below the Austin Dam and about one-half mile above Congress Ave. wagon bridge, on which the river-gage is located. Waller Creek flows into the Colorado at a point about one-half mile below that bridge. The river gage therefore showed only the flood waters coming in from Shoal Creek. The channels of these creeks are naturally narrow, and on Waller Creek houses had been built to the edge of the banks. The width of either stream at the time of the crest did not exceed ¼ mi., and possibly 6 sq.mi. of territory was submerged. The depth of the water in the middle of the channels was probably as much as 30 or 40 ft.

A second flood occurred at Austin on the afternoon of Apr. 25, with gage reading 17.5 ft. at 3 p.m. and 17.8 ft. at 7 a.m. next morning. These two floods had a fall of 8 ft. between their crests at Lagrange; but at Columbus the fall was not pronounced. At the latter station the crest passed at 4 p.m., Apr. 28, with gage reading 36.3 ft. This is 7.8 ft. lower than that recorded during the flood of December, 1913. The width of the flooded area below Columbus was from ½ to 2 mi.

Brazos River Flood

The flood in the valley of the Brazos River was much more severe than that of the Colorado, so far as property damage is concerned. But there were only five deaths by drowning. At Valley Junction, however, the flood was severe, due to an immense volume of water coming in from the Little River. On the morning of Apr. 23 unusually heavy rains were reported from the Little River watershed, with 8.29 in. at Taylor and 7.30 in. at Cameron. The river observer at Valley Junction reported a stage of 26 ft. at 7 a.m. on Apr. 23, and on the following morning he reported the gage under water and inaccessible. Later he found that the height of the water on Apr. 24 corresponded to a gage reading of 50 ft. This is 5 ft. less than the crest of the record flood of December, 1913. The crest of the flood was at Washington at 7 p.m. Apr. 27, with a stage of 52.9 ft. The stream remained stationary for 12 hr. and then began to fall slowly. It reached Hempstead on Apr. 29, with a stage of 46.5 ft.; and Rosenberg at 11 p.m. May 1, with a stage of 46.4 ft. No records were obtained from either Washington or Rosenberg in December, 1913, but at Hempstead the stream was 6.3 ft. higher in December, 1913, than in the present flood. The width of the stream ranged from about 1½ to 5 mi. at and below Valley Junction, and a few of the smaller towns were partly under water. Lowlands were deserted before the water came and stock and property moved out as far as possible.

In some places sandbanks 3 to 5 ft. high washed up, and in other places big holes and gullies were left. The crest of the flood reached the Gulf on May 6.

Trinity River Flood

The flood in the valley of the Trinity River was comparatively mild, and the resulting losses were small when compared with those sustained in the Brazos and Colorado overflows. The stream was strongly fluctuating above Dallas from Apr. 22 to 27; but at Dallas there was a continuous rise after the flood stage was reached on Apr. 23. The crest occurred at 7:30 p.m. Apr. 29 with the stage at 36.7 ft.

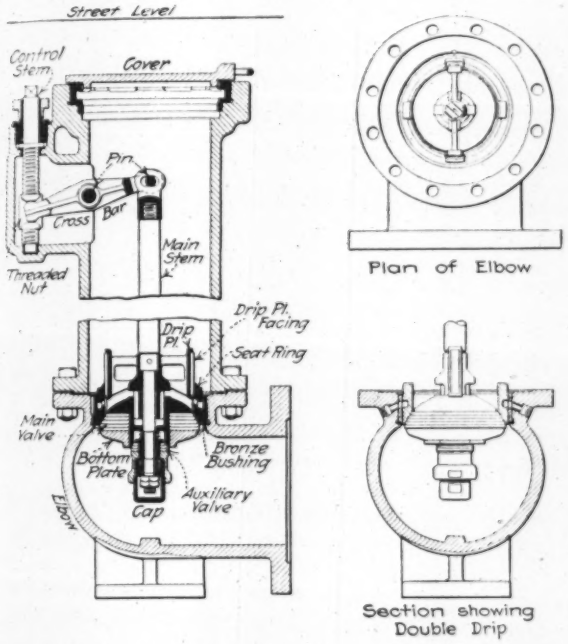
The Guadalupe flood was of comparatively short duration at Gonzales. On Apr. 21 the river got bankful at that place and then fell rapidly, but rose again on Apr. 24, and by 5:30 a.m. Apr. 25 attained a stage of 30 ft., which was the highest reported. The flood had subsided by May 5.

*The record-breaking floods in Texas in December, 1913, which caused the loss of 177 lives and property valued at $8,000,000, were described in detail by Mr. Bunnemeyer in "Engineering News," May 21, 1914, pp. 1116-1121.

†Section Director, Weather Bureau, Houston, Tex.

Cincinnati High-Pressure Fire Hydrants

The Cincinnati high-pressure fire service is being equipped with the interesting design of hydrant shown in the accompanying sketch, as made by the Kennedy Valve Manufacturing Co., Elmira, N. Y. The hydrants are designed for a working pressure of 300 lb. per sq.in. and are tested to 600 lb. The design is unusual in having the top slotted to take a head on which are the hose outlets, this feature not being found elsewhere except in the Baltimore high-pressure hydrants. These heads are carried on the hose wagons and engage by one-sixteenth turn. The hydrants are set in vaults, their tops being about 4 in. below street level. Where possible they are located between the car tracks, for accessibility and freedom from snow.



CINCINNATI HIGH-PRESSURE FIRE HYDRANT
Without hose head

Hydrant Design

The hydrant consists primarily of three parts—the elbow or inlet for introducing the water, the gate and its operating mechanism for controlling the flow of water, and the standpipe or outlet for delivering the water.

The elbow is a flanged female part made of "semisteel." Into this elbow a bronze bushing is screwed and pinned. This in turn receives the bronze seat-ring, which can be unscrewed with a wrench and removed through the standpipe. The seat-ring has a tapered seat for the valve leather and is slotted out for the drip-plate; it is also drilled and grooved so as to carry away the waste water.

The gate is made up of the main valve, which is of leather, the bronze top plate and the cast-iron bottom plate. A hole through the center of the top plate terminates at its lower end in a tapered seat for the auxiliary valve.

The standpipe is 9 in. inside diameter, has a ¾-in. wall and is made of "semisteel." Its upper end terminates in a bronze bushing which is slotted to take the hydrant-head previously mentioned.

Operation of Hydrant

When the hydrant is to be used, after its installation, the street-cover is removed from over the vault and the hydrant-cover lifted off. Then the hydrant-head is slipped into the bushing and turned to lock it in place. The joint is sealed by a rubber gasket which fits into a groove on the lower end of the head. This gasket being slightly larger in diameter than the bore of the bushing is thus partly compressed; the water pressure does the rest.

A wrench is applied to the square head on the top of the control-stem; this being turned, the main stem is moved through the threaded nut, the crossbar and the pins. The main stem carries with it the drip plate, which is faced with leather. The first movement of the stem carries the leathers over the drip holes in the seat-ring and prevents the waste of any water as it flows through the hydrant. Movement of the stem is continued until the end of the stem strikes the bottom of the cap, whereupon its further movement opens the auxiliary valve, allowing water to enter and fill the hydrant through the hole in the top plate until the hydrant and the head are full and the pressure is equalized. Still further movement of the stem opens the main valve, allowing the free passage of water. The hydrant-head is furnished with five independent hose valves which control the further delivery of water.

Springs are necessary to keep the main and auxiliary valves against their respective seats while the hydrant is being closed, thus preventing "water-hammer." These springs also serve another purpose by preventing the drip-plate facings from uncovering the drip holes until the valves are closed and pressure shut off from the hydrant.

All bearing or wearing surfaces are of bronze or heavily bushed with bronze. The iron surfaces are thickly coated with rust-resisting paint. The specifications required the following strengths of material:

	Tensile Strength, Lb.	Yield Point, Lb.	Elongation in 2 In., %	Deflection 2x1x24-In. Bar, In.
"Semisteel"	30,000	.....	.....	0.40
Manganese bronze	70,000	35,000	20	....
Bronze	30,000	.....	.....	....
Mild steel	60,000 to 68,000	At least ½ of tensile strength	25	....

High-Pressure System

The Cincinnati high-pressure fire system was designed and is being constructed by J. A. Hiller, general superintendent of the Cincinnati Water-Works.

The congested-area district to be protected is surrounded by a 20-in. ring main with two 16-in. cross mains. From these, 12-in. lines run across the district. There are four valves at each cross and three at each T, so that any block or blocks can be cut off without interfering with any of the others. These valves are in vaults with manhole covers marked to distinguish them from hydrant-vault covers. The pipes are of double-grooved hub-and-spigot cast-iron pipe, tested to 600 lb. Special parts are of "semisteel." Completed mains are tested to 400 lb. before covering.

The high-pressure pumping station, at Eighth St. and Eggleston Ave., takes filtered water at 55 lb. pressure from three city mains, a 36-in., a 40-in. and a 48-in. The station has a capacity of 75 million gallons per day.

Reinforced-Concrete Cap of Perry Memorial Column

By Howard C. Baird*

The principal feature of the Perry Memorial† at Put-in-Bay, Ohio, is a hollow shaft 300 ft. high, in the form of a Doric column, built of granite backed with concrete. It is 45 ft. in diameter at the base, 35 ft. 6 in. diameter at the echinus, and has a uniform inside diameter of 27 ft. 6 in. The abacus, or cap, which is 47 ft. 6 in. square and 7 ft. 6 in. deep, surmounts the shaft. On this cap is an

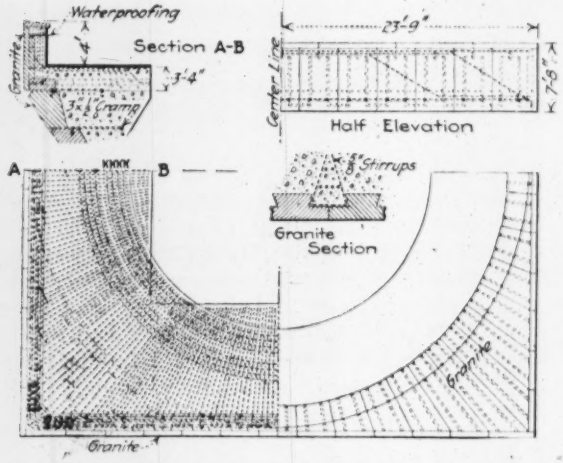


FIG. 1. REINFORCEMENT OF COLUMN CAP, PERRY MEMORIAL COLUMN, PUT-IN-BAY, OHIO

attic 17 ft. high, with a domed roof, which carries a bronze lantern 18 ft. high and weighing 11 tons.

The well, 27 ft. 6 in. in diameter, contains a reinforced-concrete frame carrying the elevator and a staircase of reinforced concrete. This construction is supported by a double set of reinforced-concrete girders 23 ft. above the base, the lower surfaces so shaped as to fit into the concrete and limestone dome over the crypt.

The structural design of the abacus, or cap, owing to architectural requirements, is somewhat unusual, and its erection was necessarily difficult, calling for a carefully devised erection outfit and very accurate placing of material under extremely disadvantageous conditions.

It was required by the architects that the granite facing forming the ceiling and sides of the cap be so secured to the construction that there would be no chance of discoloration from metal fastenings; and it was further required that the cap be adapted for use as a lookout, the floor being made of such depth as would allow the sides to form a parapet high enough to provide for the security of observers.

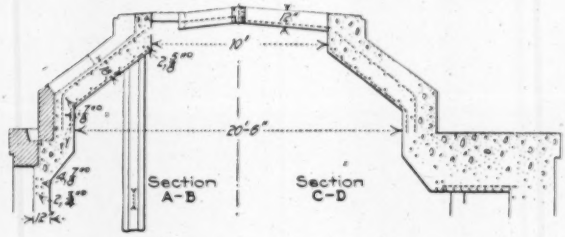
The method of attaching the 12-in. thick granite facing to the concrete of the soffit and the sides of the cap, as adopted, consisted in cutting the stones to 6 in. thick at the joints, so that the middle portions formed dovetail projections, the spaces between them having a similar shape to receive the concrete. The facing, when carefully placed in position on the falsework, made the forms for the concrete floor and parapet walls, and the concrete when placed filled up the recesses, thus firmly locking the granite slabs and the concrete together. Although the tension value of the dovetail sections of concrete is ample to support the granite, light steel reinforcement bent to shape was placed vertically in the recesses to provide security against any possible cracking.

The design of the carrying construction of this cap calls for a floor 3 ft. 6 in. thick, which, in addition to carrying its own weight and a live-load of 100 lb. per sq.ft., carries the parapet girders forming the side of the cap. The method of computing the stresses was as follows:

The floor of the cap was divided into 52 radial sections of constant depth and variable breadth, and each of these sections was considered as a cantilever supported at a point on a circle 41 ft. in diameter. The relative deflections for a load of unity at the extreme end of each of these cantilevers, varying in length from 3 to 12 ft., was then found, and the weight of the 7-ft. 6-in. parapet girder was so apportioned as to cause an equal deflection at the ends of all cantilevers, the girders being regarded as rigid owing to their comparatively great depth.

The bending moments and shears were then found in all these members, based on the above-cited distribution of load, and the reinforcement was computed accordingly. The horizontal forces from the maximum bending moments of the cantilevers were assumed to be taken up at the shaft by two rings—a tension ring 31 ft. in diameter, consisting of four 1⅛-in. rods, marked *K* in Fig. 1, and a compression ring formed of the concrete in the shaft. These rings, to be in direct tension or compression, would not be circular, owing to the variation of the horizontal forces; but the great excess of concrete provides for the flexural stresses in circular rings, the stresses in both the steel and concrete being kept within prescribed limits.

The load of the cap carried by the cantilever floor sections to the shaft causes a cantilever action on the two



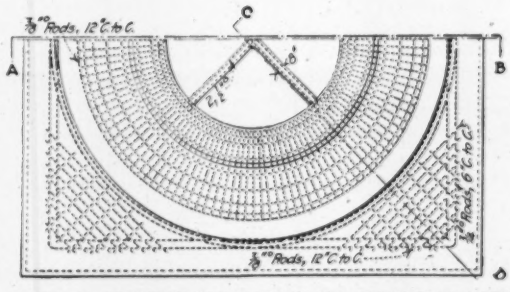


FIG. 2. DETAILS OF ROOF OF COLUMN LOOKOUT

courses of the echinus, the tension stresses being resisted in each case by 3x½-in. cramps carried back into the concrete and embracing a tension ring consisting of four ¾-in. rods, the concrete of the shaft forming the necessary compression ring as above.

In addition to the dead-loads, a live-load of 100 lb. per sq.ft. was assumed on the floor of the cap and 60 lb. per

*Boller, Hodge & Baird, Consulting Engineers, 149 Broadway, New York City.

†Described in "Engineering News," July 23, 1914, p. 172.

sq.ft. on the entire stairway for designing the columns and lower girders, in addition to the elevator loads.

During erection the cap was carried on temporary timber supports suspended from timber frames erected on the top of the shaft, and so arranged that no rods or other temporary members penetrated the concrete and granite construction, thus obviating any patching or filling up of holes in the facing of the finished column.

The architects for the Perry Memorial are Freedlander & Seymour; the consulting engineers, Boller, Hodge & Baird. The contractors for the column were J. C. Robinson & Son, who devised the erection outfit.

Cleaning a Water-Supply Main at Merced, Calif.

The successful cleaning of a long water main of moderately large diameter, without serious interruption to the service, was recently completed in Merced, Calif.

In 1888 the Yosemite Lake Reservoir was finished and the distributing pipe installed from the reservoir to a pump house at the easterly side of the city of Merced, a distance of 24,570 ft. From the pump house the line was extended across the city, a distance of 7080 ft., making a total length of 6 mi. of cast-iron bell-and-spigot pipe, all 16 in. in diameter, laid in almost a straight line for its entire length. The pipe line has numerous outlets from which water can be drawn for irrigation purposes, and in the extension across town there are the usual number of laterals required for domestic water distribution.

During the 27 years the line has been in continuous operation it has become very much incrusted, and consequently its capacity has been materially reduced. Due to this incrustation, in order to maintain an adequate supply and pressures at times of peak consumption and fires, it has been necessary for some time past to augment the supply by pumping from deep wells at the pumping station mentioned. This station is equipped with three centrifugal pumps, each with its independent drive, and each pump can draw water from either of two deep wells at the station, or from the main from the reservoir, or from both wells and main, and deliver it to the city system.

An arrangement of connections, valves and weir-box permits measurement of the water from the reservoir to the pump station, or the amount being drawn from the wells. At the time of the last investigation before the pipe was cleaned the discharge from the reservoir to the weir at the pumping station was 1220 gal. per min. under a static head of 76 ft. This is less than 60 per cent. of the discharge given in the Weston tables for flow under the given head through the same length of clean cast-iron pipe.

A contract was entered into between the owners of the water-supply and the National Water Main Cleaning Co., whereby the latter guaranteed to increase the capacity to 95 per cent. of the standard tabulated in the Weston tables for clean pipe of the same length and dimensions. A static head of 81 ft. was selected as being a fair mean of the high and low water in the reservoir. For this head and a length of 24,500 ft. of 16-in. main the discharge tabulated for clean pipe is 2285 gal. per min. Ninety-five per cent. of this would be 2170 gal. per min. The contract provided for a penalty in case the quantity delivered after the pipes were cleaned fell short of 2170 gal. per min. and a corresponding bonus if this amount were exceeded. As the discharge through the incrusted pipe was only 1220 gal. per min., an increased capacity of almost 80 per cent. was thereby guaranteed.

The device used for cleaning the pipe is shown in the accompanying photograph. In its operation and propulsion the turbine motor principle is applied, the water pressure behind the machine forcing it forward through the pipe and at the same time rotating the vanes and scrapers that remove the incrustation. For pipe 10 in. or more in diameter the machines are all self-propelling. Through pipe of smaller diameter they must be pulled with wire cables.

PIPE CLEANER AND DEPOSIT REMOVED

As noted in the foregoing, the pipe line at Merced was practically straight, having in its entire length no sharp bends or elbows. This condition is favorable for the use of the method described, since it diminishes the number of cuts that must be made in the pipe. In a straight pipe this number will be determined by the amount of incrustation in the pipe. The photograph shows the amount of deposit removed from the 7080 ft. of 16-in. pipe between the pump station and the end of the town main. This distance was traversed without removing the machine from the pipe line. The material removed from the pipe in this distance made a pile 10 ft. in diameter and 4½ ft. high.

Both before and after the pipe was cleaned the discharge was measured by directing the flow through a well-constructed concrete weir-box, provided with a thin steel plate crest 36 in. long. After cleaning the pipe, the depth of water over the weir was 7.75 in. By Smith's modification of Francis' formula, the quantity then flowing was $3.29\left(L-\frac{H}{10}\right)H^{\frac{1}{2}}$, or 2249 gal. per min. By the same method the flow before cleaning the pipe was 1220 gal. per min. The amount guaranteed was 2170 gal. per min.; so a bonus was earned by the contractors. The total cost for cleaning the pipe amounted to 15c. per lin.ft.

Orla Casad is superintendent of the water service for the town of Merced. B. B. Hodgmann, Chief Engineer of the National Water Main Cleaning Co., performed the contract and E. P. Jones was the consulting hydraulic and mechanical engineer.

Tests of Frictional Resistance of Concrete on Shale

By E. L. Lasier*

SYNOPSIS—A determination of the value of coefficient of frictional resistance to sliding of concrete blocks on shale, shale on shale and concrete cast on shale. Made on shale foundation of dam under construction.

Two years ago, during the early stage of construction of the so-called State Line Dam of the Hydro-Electric Co. of West Virginia, a series of experiments was conducted to determine the coefficient of frictional resistance against sliding. The dam is being constructed on Cheat River in West Virginia near Cheat Haven, Penn. It is of mass concrete. The foundation is a hard, dark bluish shale without pronounced laminations. In the belief that a report on the tests conducted will be of value to engineers, and with the approval of F. W. Scheidenhelm, Consulting Engineer and Chief Engineer of the Hydro-Electric Co. of West Virginia, the writer presents herewith the results of the experimental study.

It was desired to determine the value of the coefficient of frictional resistance to sliding offered by concrete upon shale and shale upon shale without bond resistance; also by concrete upon shale with bonding resistance included. Further, it was sought to ascertain the comparative value of the coefficient (more commonly known as the "coefficient of friction") when the surfaces of contact are dry and when they are thoroughly wet.

In the determination of the coefficients of friction without any bonding resistance, for both concrete on shale and shale on shale, and with the surfaces of contact both

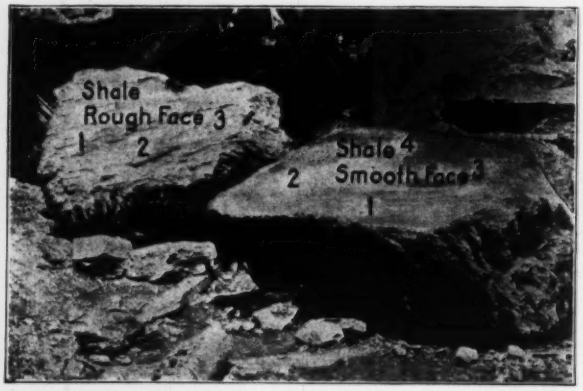


FIG. 1. TWO LARGE BLOCKS OF SHALE ON WHICH SPECIMENS WERE PLACED

dry and wet, the materials shown in the photographs (Figs. 1 and 2) and the device shown in Fig. 2 were used.

Two large blocks of shale (Fig. 1), each having a face approximately 3x4 ft., were selected. One of these blocks had a rough face; the other a smooth one, although the photograph gives the exaggerated impression that the latter is smooth to the extent of being polished. Upon the face of the rough block three reference localities were selected, numbered 1, 2 and 3, of varying degrees of roughness; upon the smooth block four reference localities were selected, numbered 1, 2, 3 and 4, of varying degrees of smoothness. Upon these relatively large surfaces of shale, concrete and shale specimens were successively placed and the large shale blocks jacked up until the specimens placed upon them commenced to slide.

The concrete and shale specimens used, together with the condition of the faces used in contact, are shown in

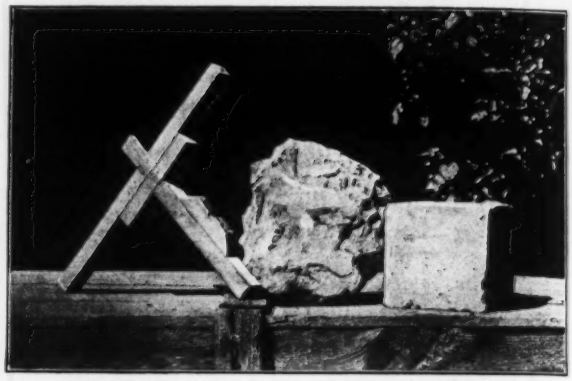


FIG. 2. SHALE AND CONCRETE SPECIMENS AND SLOPE MEASURE

the photograph (Fig. 2). The concrete specimen was a 6-in. cube, five months old, made of Cheat River crushed gravel and sand. The shale specimen had an area of contact of approximately 8x8 in. and was 4 in. thick.

The device used for measuring the slope of the face of the stationary shale block at the instant sliding commenced is likewise shown in Fig. 2. It consisted of two wooden pieces at right angles to each other. The piece with the level on it was used as the horizontal leg, free to move up and down in the same vertical plane. The vertical leg was graduated in inches. The effective length of the horizontal leg was exactly 10 in. Thus the components of the tangent of the angle formed with the horizontal by the face of the stationary block at the time the

TABLE 1. COEFFICIENTS OF FRICTION

Concrete Specimen on Stationary Shale Blocks

Smooth Stationary Block of Shale			Rough Stationary Block of Shale		
Reference Location	Dry	Wet	Reference Location	Dry	Wet
1 very smooth	0.61	0.63	1 fairly rough	0.75	0.73
1 very smooth	0.65	0.62	1 fairly rough	0.79	0.68
2 smooth	0.73	0.69	2 rough	0.78	0.73
2 smooth	0.72	0.69	2 rough	0.88	0.75
3 fairly smooth	0.72	0.67	3 very rough	0.88	0.81
3 fairly smooth	0.74	0.66	3 very rough	0.94	0.78
4 slightly rough	0.73	0.70			
4 slightly rough	0.73	0.69			
Average	0.704	0.669		0.837	0.747

Shale Specimen on Stationary Shale Blocks

1 very smooth	0.57	0.55	1 fairly rough	0.70	0.68
1 very smooth	0.54	0.54	1 fairly rough	0.76	0.71
2 smooth	0.58	0.53	2 rough	0.77	0.73
2 smooth	0.61	0.54	2 rough	0.84	0.75
3 fairly smooth	0.61	0.54	3 very rough	0.85	0.78
3 fairly smooth	0.62	0.54	3 very rough	0.90	0.83
4 slightly rough	0.64	0.58			
4 slightly rough	0.69	0.59			
Average	0.608	0.551		0.803	0.747

*Formerly engineer in charge of tests, Hydro-Electric Co. of West Virginia; present address, Engineering Department, Bureau of Standards, Washington, D. C.

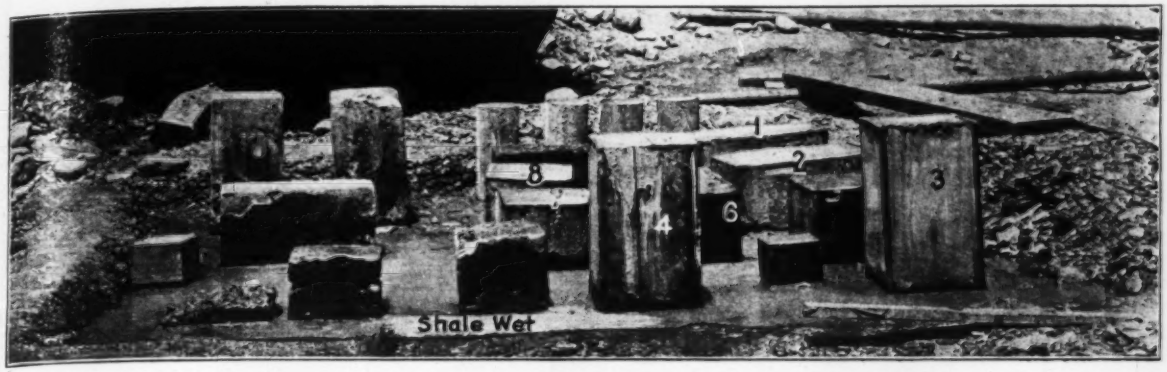


FIG. 3. CONCRETE SPECIMENS POURED ON EXPOSED BED SHALE
Only those numbered in view were tested

specimen commenced to slide were quickly read. Consequently the corresponding coefficient of friction—the tangent of the angle in question—was easily determined.

Table 1 shows the values found for the coefficient of friction for concrete on shale and shale on shale, with the surfaces of contact dry and also with them thoroughly wet. Two values were obtained, and are stated for each reference location, under each condition, showing the variation in the values of the coefficients found.

In the determination of the resistance to sliding of concrete on shale, including the bonding resistance of the concrete on the shale, the test specimens shown in the photographs (Figs. 3 and 4) were used.

An area of about 9x12 ft. of exposed bed shale rock within a coffer-dam was selected. By means of pick and shovel the loose shale was removed until a solid shale surface was presented. This surface was made approximately as rough as that used as the foundation of the dam. Upon this prepared section eight concrete specimens (numbered 1 to 8 in Fig. 3) were poured. Specimens Nos. 1 to 6 were rectangular prisms, 1x1x2 ft.; specimens Nos. 7 and 8 were 1-ft. cubes. The concrete used for making the specimens was taken from that being poured at that time into a portion of the dam. It was composed of Alpha portland cement, Cheat River gravel and a mixture of Cheat River crushed sand and Monongahela River sand, in 1:3:6 proportions.

Water was permitted to stand upon the shale surface so as to keep it thoroughly wet (see Fig. 3). The concrete specimens were allowed to age 8 days. Then the water upon the shale surface was drained off preparatory to making the tests. In Fig. 3 other concrete specimens than those marked 1 to 8 are to be observed. These additional unmarked blocks were prepared for the tests, but were damaged by water completely covering them before the concrete had set sufficiently, rendering them unfit for testing.

The device used in order to cause the specimens to slide on the shale bed is shown in Fig. 4. The method employed

TABLE 2. RESISTANCE TO SLIDING

Specimen Number and Shape	Weight (W) Lb.	Dynamometer Reading, Lb.	Leverage Ratio	Fric. and Bond. Resist. (R) Lb.	Ratio or Coeff. of Resist. $\left(\frac{R}{W}\right)$	Remarks
1	301.75	165	9:1	1485	4.93	75 per cent. shale failed (a)
2	307.25	155	18:1	2790	9.09	20 per cent. shale failed (a)
3	292.50	115	8:1	920	3.14	40 per cent. shale failed (a)
4	291.75	175	6:1	1050	3.61	80 per cent. shale failed (a)
5	300. (assumed)	100	16:1	1600	5.33	See note (b)
6	300. (assumed)	50	18:1	900	3.00	See note (c)
7	153.00	135	8:1	1080	7.06	5 per cent. shale failed (a)
8	155.25	100	8:1	800	5.15	10 per cent. shale failed (a)
Average					5.163	

(a) "75 per cent. shale failed" means that concrete block parted from shale over only 25 per cent. of the total area of contact. Over the remaining area 75 per cent. failure occurred within the shale rock.

(b) Concrete sheared entire length of specimen 3 in. from plane of contact. When the 3-in. layer adhering to the shale was dug up with a pick, shale adhered to the bottom of the concrete.

(c) Concrete sheared entire length of the concrete specimen 1 in. from plane of contact. Otherwise the same remarks as in (b) apply.

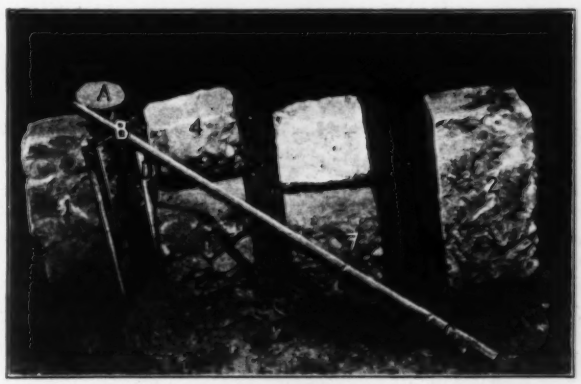


FIG. 4. CONDITION AFTER FAILURE OF SURFACES OF CONTACT

in using this device is indicated in the sketch shown in Fig. 5. The plate *A* was brought to bear against the proper face of the specimen below the center of gravity of the latter so as to cause the resultant of the force exerted and of the weight of the specimen to fall well within the base of the specimen, thus tending to eliminate lifting or overturning of the specimen. The force was exerted at a measurable length along the arm *C* from the fulcrum *B*, and read by means of a spring balance with a capacity of 200 lb. The legs *D* were used as braces. The force being then gradually increased, that pressure against the side of the specimen which just caused sliding was then determined from the reading of the spring dynamometer and the leverage ratio.

The condition after failure of the surfaces of contact of the concrete specimens, excepting Nos. 5 and 6, is seen in Fig. 4. This shows how in every case some of the bedrock shale adhered to the concrete specimen.

The values found for the resistance to sliding, including both frictional and bond resistance, of concrete on shale are shown in Table 2. The several values of the resistance are expressed also as "coefficients"—ratios of the resistances to the weights of the corresponding concrete blocks.

Evidently the frictional and bonding resistance of one shale layer on another was less in certain areas than was the resistance of the concrete on the shale in the overlying area. Attention is called to the large variation of the coefficient for specimens Nos. 1 and 2. There was, however, 55 per cent. more of the total area of the face of contact covered with shale in the case of No. 1 than in the case of No. 2.

Regarding the tests on specimens Nos. 5 and 6, the query naturally suggests itself: Would the concrete have sheared in the manner reported in the notes under Table 2 if it had been, say, 28 days instead of 8 days old? Furthermore, there is the possibility, in spite of the care exercised, that the arm *c* (see Fig. 5) of the lever was not vertical when the force was exerted to make the specimen slide. A very slight inclination of the arm *c* with a vertical line through the fulcrum *b* would, it is readily seen from Fig. 5, cause the direction of the force exerted upon the specimen at the plate *a* to be other than horizontal. If this inclination of *c* be toward the right (looking at the figure) of the vertical through *b*, the line of action of the force at *a* upon the specimen would be slightly up, instead of horizontal. Hence a lifting as well as a sliding force might have been exerted upon specimens Nos. 5 and 6.

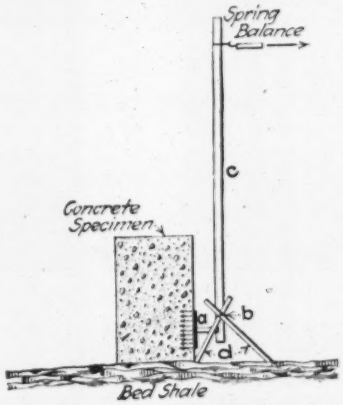


FIG. 5. DEVICE USED TO APPLY PRESSURE ON BLOCKS

Conclusions

1. The resistance to sliding of shale on shale is less than that of concrete on shale.

2. The resistance offered when surfaces of concrete and shale are in contact is approximately 10 per cent. greater than when both surfaces are of shale.

3. With wet surfaces of contact the frictional resistance is materially less than that offered by dry surfaces of contact.

4. The resistance when the surfaces in contact (both concrete on shale and also shale on shale) are wet is reduced to from 89 to 95 per cent. of the resistance when the corresponding surfaces are dry.

5. Findings as regards frictional resistance to sliding in the case of the shale rock investigated may be summarized as follows:

	Surfaces Dry		Surfaces Wet	
	Coef. of Friction	Aver.	Coef. of Friction	Aver.
Concrete on smooth shale	0.61 to 0.74	0.704	0.62 to 0.70	0.669
Concrete on rough shale	0.75 to 0.94	0.837	0.68 to 0.81	0.747
Shale on smooth shale	0.54 to 0.69	0.608	0.53 to 0.59	0.551
Shale on rough shale	0.70 to 0.90	0.803	0.68 to 0.83	0.747

6. Frictional and bond resistance to sliding of concrete on the shale in question has a "coefficient" (or ratio of the horizontal force to weight) varying from 3 to 9.09. This variation is relatively so great that the limiting values, as determined experimentally, should be considered rather than the average value of 5.163.

Foundation Piles Cut Off Above Water Line

The buildings on the new municipal pier at Chicago have concrete column footings on pile clusters. These piles are cut off at heights of from 1 ft. 9 in. to 5 ft. 3 in. above the water line, as provided in the plans of the Harbor and Subway Commission, of which E. C. Shankland is chairman and chief engineer.

This construction was objected to by the building commissioner, Mr. Ericsson, who pointed out that the building ordinance requires all piles in foundations to be cut off 1 ft. below datum (water level). The present commissioner of public works, Mr. Moorhouse, appointed three engineers to investigate the matter—Col. W. V. Judson, U. S. A.; R. W. Patterson, and C. W. Cartlidge, Bridge Engineer of the C., B. & Q. R.R. The main part of their report is given below.

When it is considered that this ordinance for pile cutoff must provide for safe construction of buildings all over the city and subject to widely varying soil conditions the wisdom of this provision is evident. But it is not clear that it is necessary, from an engineering standpoint, to conform to this provision if conditions of soil, exposure, etc., in a specific case are such that piles cut off above the prescribed plane will not be subject to decay. Of course it is the general rule in such cases that timber will decay unless always dry or always wet, although protection (or lack of protection) from air currents is an important factor.

The plans for the municipal pier provide that the piles be cut off at heights varying from 9 in. below datum under the headhouse to from 1 ft. 9 in. to 5 ft. 3 in. above datum under the sheds proper, the bottom of the concrete footings being in all cases 9 in. below the cutoff. In all probability the piles will be continually moist and surrounded by moist clay or sand, and will be protected from circulation of air by the inclosing dock walls and the reinforced-concrete floor. The nearness of the water, the permeability of the walls retaining the pier, the sealing of the earth fill by a concrete floor, and the circumstance that the fill is largely hydraulic, and thus may not be expected to settle away from the pile tops, are conditions favorable to their life.

It is true that conformance with the building ordinance would have provided insurance against the remote probability of the decay of the tops of these piles; but on the other hand the cost would have been materially increased, and the increase would have been excessive as insurance. In the committee's opinion, while some decay of the tops of these piles is possible, it is a remote contingency. If it should occur, the damage would be slight and not such as to endanger either the structure or the lives of its occupants, and it would be easily and cheaply repaired.

The committee further states that the harbor commissioners have abundant precedent for their adoption of this feature, and have been more conservative in this respect than the designers of the piers at Portland, Ore., and Boston, where the piles were cut off 19 ft. and 9 ft. respectively.

Transmission-Line Towers: Foundations and Erection

A series of papers and discussions at the recent convention of the American Institute of Electrical Engineers brought to light the practice of several power companies in providing adequate supports for transmission-line steel towers and in erecting these structures. The leading points are summarized below.

Pennsylvania Water & Power Company

J. A. Walls, Chief Engineer of the Pennsylvania Water & Power Co., reported that, on the line from Holtwood (or McCall Ferry) to Lancaster, bell-bottomed concrete foundations had been used, and also on the anchor towers

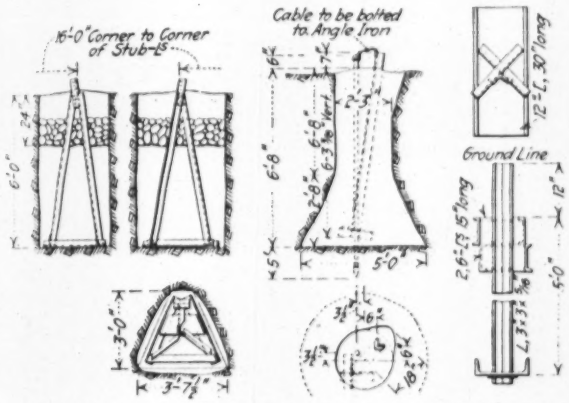


FIG. 1. OLD TOWER FOUNDATIONS; PENNSYLVANIA WATER & POWER CO.

of the Holtwood-Baltimore line. Buried steel tripod stubs were used for the intermediate towers of the latter line. Lifting tests were made on steel single-leg and tripod stubs (the former with top and bottom fins) and the bell-bottomed concrete supports. The single-leg stub pulled out at about 23,000 lb., the tripod type at 32,000 lb. and the concrete was untouched at 70,000 lb., the capacity of the testing outfit. These supports are shown in Fig. 1.

Concrete Footings

For the second Holtwood-Baltimore line (a short and important trunk of very heavy construction) it was decided to use concrete stubs, and four types were investigated—(1) bell-bottomed without forms, (2) bell-bottomed with steel forms, (3) bell-bottomed with wood forms, and (4) truncated pyramids with wood forms. They were more or less satisfactory, in the order named, and the first type (Fig. 2) was selected.

Post holes 3 to 4 ft. deep and 16 in. in diameter were dug and the bell scooped out with a spoon. If the soil for any hole was too hard for this, a half-stick of 40% dynamite was first shot in a small hole punched down about 2 ft. In rock two or three shots generally opened an entire hole. Ordinarily, one man dug two or three holes per day. One man was put on each hole and a foreman had charge of three or four gangs. Holes were laid out by rods and cord from reference stakes, only about 5 min. being required for a base. Attempts were made to shoot out the holes in ordinary soil with a full stick of 60% dynamite and two half sticks of 40%, but this was not generally successful.

Materials, Labor and Cost

The concrete mix varied from 1:2:4 to 1:3:5. Sand and ¾-in. stone were shipped in carload lots to various stations along the line and distributed by four-mule teams—1.5 yd. of stone and 3.4 yd. of sand being dumped at each tower site. These amounts were increased 50% at each fifth tower. Cement was stored in farmers' barns—100 to 200 bags to a place. Mixing and pouring for one tower required about ¾ hr., while moving and setting up required about an hour. A 2.5-cu.ft. hand mixer on two wheels was used. It weighed 1000 lb. with platform. A portable runway elevated the mixer enough to let a wheelbarrow go under the chute. Water was hauled in a two-horse steel tank, which was filled with a 4-in. boat pump from creeks. It would have been better to use a lighter wagon with a small suction pump and 15 ft. of hose.

The smallest number of men needed in concreting was nine—under one foreman. Two or three more men were often used to advantage, especially in moving. One to three teams were employed, depending on the length of haul for water and cement. Water in the anchor holes was pumped out. A short length of 6-in. sheet-iron pipe for depositing concrete would have been better where holes filled fast.

The tower bed plates were not on hand at first and dummy plates were tried, but did not give a good seating for the plates. Some piers were left 8 in. below grade and finished with the plates later. After the bed plates were on hand the concrete was poured to within 1 in.

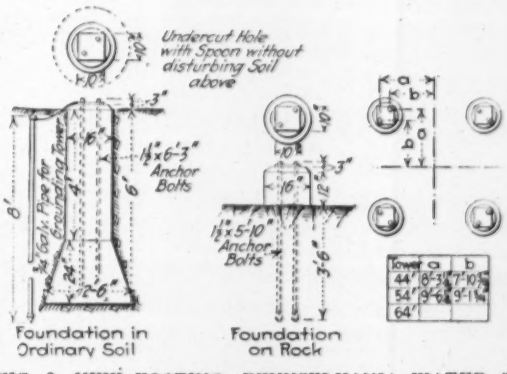


FIG. 2. NEW FOOTING; PENNSYLVANIA WATER & POWER CO.

of the top of the anchor bolts and the plates hammered down on the soft concrete to the grade given by the instrumentman.

The actual cost per tower averaged:

Hauling	$13.20
Grading	2.27
Digging	4.92
Materials and concreting	28.50
Total	$48.89

The steel was assembled on the ground in a horizontal position and towers were erected by a rigging gang of 11

men, a foreman and a four-mule team. The tower legs were pivoted on the foundation and the head lifted by a tackle going from below the cross-arms over a 42-ft. shear leg to five dead-end pins ahead. Back and side guy tackles were also used. For raising the shear leg the back guy was as long as the main tackle. The main lead line was hauled in very slowly until the weight of the shear leg, which was lashed by a long cable to the tower, was sufficient to pull the tower over. One pair of foundation shoes were fitted and guided over the bolts and then the tower was rocked ahead for the other pair.

Alabama Power Co.

W. E. Mitchell, Operating Manager of the Alabama Power Co., described the development of some all-steel footings which were necessary on account of the absence of local concrete materials and the existence of bad hauls of from 4 to 10 mi. from railway stations.

The test loads on towers were (1) a horizontal pull in the direction of the line at any insulator, (2) a vertical load of 1200 lb. on the end of all crossarms, and (3) a

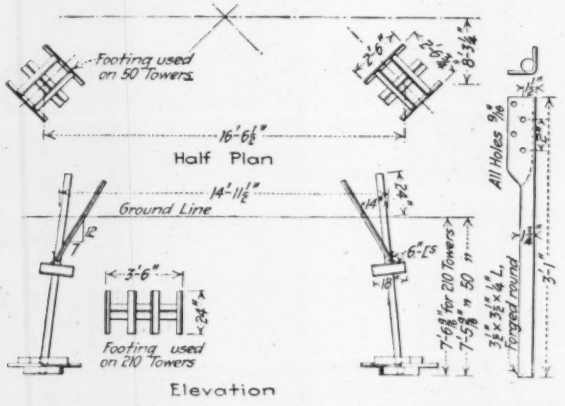


FIG. 3. STEEL FOOTING; ALABAMA POWER CO.

transverse pull of 5000 lb. on the middle crossarm, combined with 7000 lb. longitudinal pull on the top arm along the center line of the tower. In determining the size and depth of footing it was assumed that tension in a leg stub was withstood by a truncated cone of earth (100 lb. per cu.ft.) sloping outwardly from the footing base at 30 deg. to the vertical. A fair bearing pressure was assumed to carry thrust. A 6¼-sq.ft. base buried 7½ ft. gave a safety factor of 2. A grillage 2½ ft. square was at first used, but was later changed to 2x3½ ft., as the men in excavating for the first type had to dig a hole at least 2½x4 ft. The second grillage weighed more; but the saving in field work more than offset the extra cost.

Horizontal Thrust

It had been seen in the field that the legs tended to move due to the component of stress in the lowest diagonal, even though the earth was well tamped. Therefore it was decided to make the leg and the lowest diagonal junction 2½ ft. below ground and to put on here at right angles two 18-in. lengths of 6-in. channels (Fig. 3).

A tower with these footings was tested to destruction. Bolts in the upper part sheared, but the legs did not move.

In many cases the leg foundations were on stable rock. Then a 2¼-in. hole was drilled and a 3-ft. length of steel angle, the same size as the tower leg and forged round for 2 ft. of its length, was grouted in and bolted to the leg.

Location and Excavation

Towers were located by a field engineer from office plottings on a profile; reference hubs were set and depth of excavation marked. For the holes 40% dynamite was used and practically all holes were shot. A portable air compressor and hand drills, where they could be brought up, saved 25% over hand drilling in rock.

All four stubs were set and leveled at once, using a template. Backfill was carefully tamped. Towers were assembled flat, the insulators were hung and the structure was raised with a ginpole. The total cost of footings averaged $28 per tower; assembling the 4800-lb. tower cost $10, and erection, $5.

Pacific Gas & Electric Co.

P. M. Downing, Engineer of Operation and Maintenance of the Pacific Gas & Electric Co., reported that metal footings without concrete were not recommended. Permissible stress borne by dry, well-tamped earth was not always obtained when the soil was water-soaked. Towers have failed on a number of lines constructed with metal footings, and it has been necessary to reinforce them with concrete.

Recommended Footings

For 75- to 80-ft. double-circuit towers spaced 800 ft., each footing should contain at least 1¼ cu.yd. of concrete and be of the form shown in Fig. 4. Assuming concrete to weigh 140 lb. per cu.ft. and earth 110 lb., and the earth-cleavage angle to be 30 deg., these footings give a safety factor of about 2.

The cost, when the route is about equally divided between mountain and valley sections, averages as follows, for labor at $3 per day, concrete hand mixed at each tower, and a 6-mi. haul of material:

Labor	$10
Material	16
Hauling	34
Total	$90

Where the line is not too steep, erection is most economical by assembling on the ground and up-ending with a ginpole. A very satisfactory way has been to set a 35-ft. ginpole just outside the footings and hold it with three

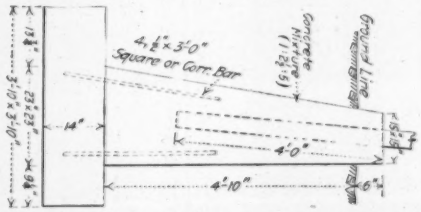


FIG. 4. REINFORCED-CONCRETE FOOTING; PACIFIC GAS & ELECTRIC CO.

guys running to iron-pin anchors. A flexible steel cable goes from the tower, at the lower crossarm, over an open sheave at the top of the pole and to a set of triple blocks anchored about 400 ft. from the tower base. A back guy is necessary to hold the tower as it comes into a vertical position; side guys are unnecessary except in windy weather. If the ground around the footings is not well packed, hold-back anchors are advisable for the lower

tower legs to prevent damaging the footings. A 3-ton motor truck is the best motive power for raising the towers and for transporting equipment. Nine men with a truck will raise and fasten down an average of nine towers in a 9-hr. day.

Toronto Power Co.

Notes on the old and new 60,000-volt lines from Niagara Falls to Toronto were contributed by F. C. Connery, Superintendent of Transmission Lines of the Toronto Power Co. About 100 sets of the type shown in Fig. 5 were dug up after seven years' service. In no case was the galvanizing deteriorated, and the impregnated wood blocks were in a fair state of preservation. These were used with standard 40-ft. two-circuit towers. With some 53-ft. double-circuit towers the wood blocks were omitted. Six such towers were erected in black muck, which gave no resistance with borings to 40 ft. Plank sheathing was driven around each leg location, the muck dug out and a floating foundation of impregnated 2-in. plank put down at 6 ft. below the surface. The stubs were set in concrete about 1 yd. to a footing. There has been no settlement or change of alignment in a year.

Stubs were bolted to a steel template lined up on center-line stakes and leveled with a carpenter's level. One man backfilled, while two tamped, water being used when available to settle the earth.

Narrow-Base Towers

A type of very narrow-base latticed towers or poles was employed on a 6x6x6-ft. 1:3:5 concrete base with twelve 1¼-in. anchor bolts. The foundations for some of these

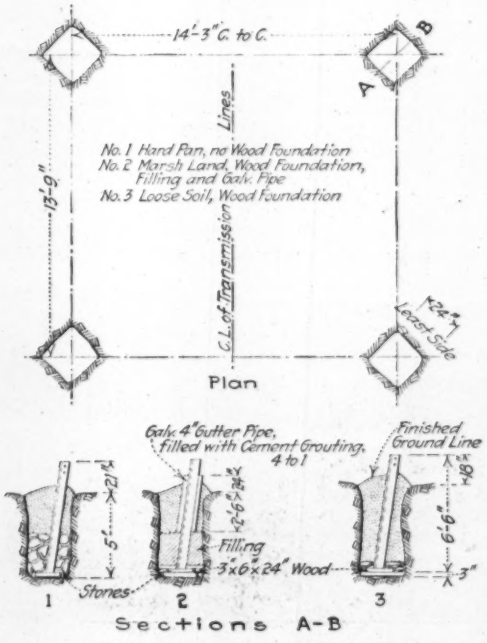


FIG. 5. FOUNDATIONS FOR 40-FT. TOWERS; TORONTO POWER CO.

poles varied beyond a minimum depth of 6 ft.; then they were erected on 12 in. of concrete and the excavation filled with concrete around the pole.

New tower footings are now being designed as follows: (1) Modified screw guy anchor for light structures, (2) a screw guy anchor with a large footplate on a shallow concrete slab, (3) a screw pile with top plate for the tower foot plate, and (4) threaded wood pile. It has been found unnecessary to drive a pile to refusal to get a good tower footing, there being sufficient skin friction in the upper layers of soil.

American Bridge Co.

J. B. Leeper, Manager of the Tower Department of the American Bridge Co., held that the ability of a tower to resist its loads depended largely on properly designed anchors, in designing which both vertical and horizontal

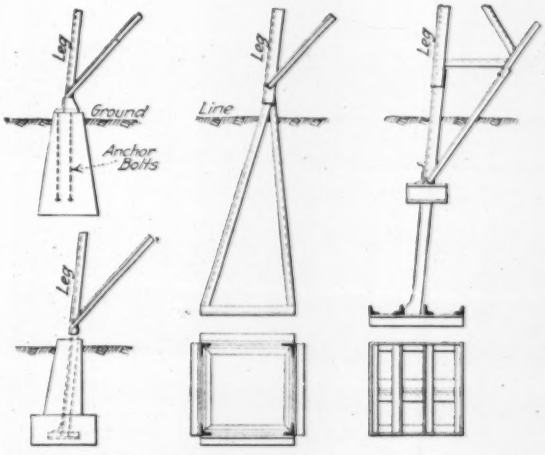


FIG. 6. TOWER FOOTINGS; AMERICAN BRIDGE CO.

forces had to be kept in mind. It has been found that if the uplift is properly cared for there will be ample provision for compression. Tests of the company show that the common assumption of the stub being held down by an inverted frustrum of earth, etc., gives no allowable overload with freshly tamped earth.

Horizontal Thrust

The failure of many towers has been due to insufficient provisions for horizontal force. Most of these failures have been with single-leg angle stubs which have little resistance to the horizontal component of bottom diagonal stress. There are several effective designs, such as (1) a concrete footing with anchor bolts, (2) a single-leg angle stub embedded in a concrete footing, (3) four battered angles extending from the tower leg to a base frame of angles, and (4) a single stub angle going down to a steel grillage and with the bottom diagonal attached 2 ft. below ground where channels resist side thrust.

Concrete anchors are stable and permanent but generally too expensive. Steel anchors, if properly designed, may be made practically as permanent as concrete and much less expensive. The fourth type in Fig. 6 has several advantages: (1) The leg splice can be kept far enough above ground to prevent serious corrosion, (2) by splicing the stub about 3 ft. below ground the ground-level parts can be renewed at small expense, (3) setting, backfilling and tamping is easy, (4) the amount of steel is small and the shopwork is inexpensive.

Boulder Parapet for Roadways in Palisades Interstate Park

The Palisades Interstate Park Commission is constructing a 15-mile roadway from the Bear Mountain playground, an excursion resort which the commission has developed on the Hudson River 5 mi. below West Point, westward through the great Harriman Park forest tract in Orange and Rockland Counties, New York, to Southfield on the Erie R.R. The commission is also proceeding with the construction of the long-planned Henry Hudson Driveway, which is to be built under the Palisades along the west shore of the Hudson River, opposite New York City.

In planning the construction of these roadways, built through rough mountainous country, and chiefly for automobile traffic, it was desired to safeguard those using the roadways from the danger of going over high embankments in case of skidding wheels, breakage of steering gear, or other accident.

The ordinary wooden guard rail commonly used along highways furnished some safeguard in the days of horse-drawn traffic, but is wholly inadequate to prevent machines of the weight and speed of modern automobiles from going

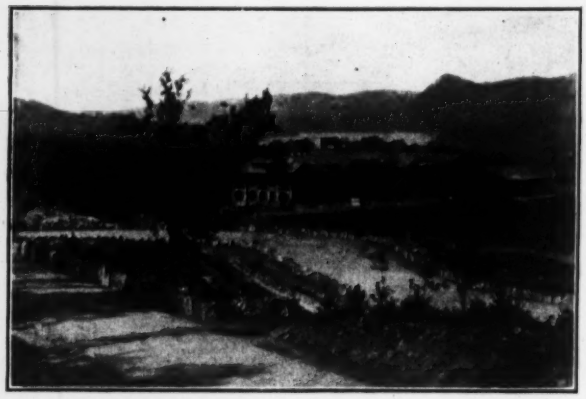


FIG. 1. BEAR MOUNTAIN INN OF THE PALISADES INTERSTATE PARK COMMISSION, IN THE HUDSON HIGHLANDS

In the foreground is the first loop in the road under construction from Bear Mountain to Tuxedo, showing the lines of boulder parapet

down the bank. A limited use has been made of concrete guard rails; but while they have the advantage of permanence as compared with wooden posts and rails, they have little more strength against impact.

It was therefore determined to use on the Interstate Park roads a parapet made either of boulders obtained from the fields along the route or blocks of stone secured from the numerous rock excavations. The original plans for this parapet were made under the direction of C. W. Leavitt, when Chief Engineer of the commission, and the actual construction has been carried out under the direction of the present Chief Engineer, W. A. Welch.

The accompanying views, taken in the vicinity of Bear Mountain along the roadway referred to, will give a clear idea of the appearance of the completed parapet. Most of the blocks of stone used are very large and heavy, weighing from one to two tons. They are placed on the shoulder of the road and roughly lined up on the roadway side. No expense is incurred in dressing the stones to regular form. To carry these stones from the ledge out of which they are blasted and place them in position on the shoulder of the road, a very effective traveling derrick has been built, and is shown in one of the accompanying photographs. The machine is a substantial four-wheel wagon carrying a low tripod from which a tackle block is suspended. A rope runs through this tackle block and is connected to a geared windlass over the rear axle of the wagon. This wagon is backed over a stone to be lifted, chains are put around the stone, it is hoisted free of the ground and hauled to the place where it is wanted. By this rig, stones are placed so close to the final position that very little work with bars is required to line them up on the shoulder of the road.

FIG. 2. A MOUNTAIN LAKE ON THE BEAR MOUNTAIN-TUXEDO ROAD

Note the large size of the stones in the parapet

This boulder parapet is so heavy and substantial that it furnishes an absolute safeguard against machines going over the bank. Of course if a careless driver or some mishap causes a car to run against the parapet, the car is apt to suffer, but the boulders will stand the impact, and there is little chance that the machine will turn over.

With the abundant stone available along the line of the road, this boulder parapet which costs only 50 to 60c. per linear foot, has proved cheaper to build than even a wooden guard rail. When it is once placed no expense for maintenance is required. If through frost action or other causes some of the stones should in the course of years settle out of line, it is a simple matter for men with bars to go along the road and bring them back to position.

FIG. 3. LOOKING UP THE HUDSON FROM THE ROAD TO BEAR MOUNTAIN INN

FIG. 4. VIEW OF ROAD AROUND THE SHOULDER OF BEAR MOUNTAIN

The construction may possibly be criticized from the artistic point of view, because of the jagged and rough appearance of the row of boulders. This can be remedied, however, by planting vines and creepers on the shoulders all along the roadway, and in a short time the rough stones will have become covered with a mass of verdure.

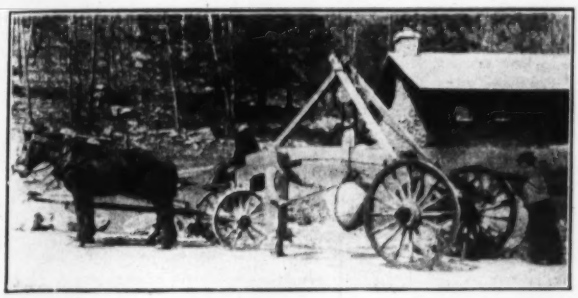


FIG. 5. DERRICK WAGON USED IN PLACING BOULDER PARAPET ON BEAR MOUNTAIN ROAD

and the stones will eventually become weathered to the color of other country rock along the way.

In the construction of the Henry Hudson drive along the Palisades, nearly all of which road is in sidehill cutting along a steep slope, the lower side of the road is to be protected by a continuous row of huge blocks of trap rock, roughly rectangular in outline. In this case the rock along every foot of the roadway is available for building the parapets on the lower side. To place this rock, another type of wheel derrick is used, shown in Fig. 6.

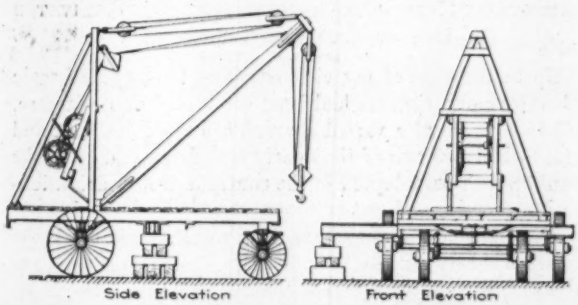


FIG. 6. PORTABLE DERRICK FOR PLACING BOULDER PARAPET ON HENRY HUDSON DRIVE
(Built by John T. Horton, New York)

Brick and Stone Pavements Without Sand Cushions

There is an increasing tendency toward eliminating the sand-cushion course in all kinds of block pavement. It has long been demonstrated that a mortar bed is preferable for asphalt blocks, and a mortar-bedded wood block is the common European method and has many advocates in this country. Experiments with mortar beds for stone-block pavements at Schenectady and New York City and with brick pavements in Cuyahoga County, Ohio, have recently been noted in *Engineering News*.

Now comes the news that the cushion coat has been entirely eliminated in the construction of a brick pavement at Paris, Ill. The bricks were laid on the green concrete base and gently rolled with a 600-lb. hand roller. This work was done under the supervision of W. T. Blackburn, Consulting Engineer of the Dun Wire-Cut-Lug Brick Co., and W. W. Marr, State Highway Engineer of Illinois.

Official notice has also just been received that the Borough of Manhattan, New York City, has abandoned the use of a sand cushion for granite-block pavements. Under the present specifications a mortar bed of 1 part cement and 3 parts sand, mixed dry, is used. The mortar hardens in a few weeks, even under traffic. An asphaltic filler is used for the joints.

The great advantage claimed for the mortar bed over the sand cushion is that water leaking through the joints of the blocks does not cause depressions in the surface, which was the case with the sand cushion, and the cost of maintenance is considerably reduced. Eugene W. Stern is Chief Engineer of the Bureau of Highways of the Borough of Manhattan.

From the foregoing the conclusion might be drawn that cushion course of block pavements has survived for no particular reason. But research on this subject shows that when modern squared stone-block pavements were introduced in Paris, in the seventies, they were first laid directly on the concrete foundation. M. Alphand, Director of Public Works of Paris, reported to the Municipal Council of that city that the result was "an enormous hubbub in the street and a continual shaking of the houses," and furthermore the pavement between the concrete and the carriage wheels was as if between a hammer and an anvil, and the stone wore out, although of very good quality. He accordingly sought to obtain the necessary elasticity by putting a layer of sand between the concrete and the stone blocks.

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Losses of Merchant Shipping during the past ten months of war, according to statistics published by the "Journal of Commerce," aggregate 511 vessels, with a total tonnage of 915,457. This is approximately 2% of the total merchant shipping of the world. At the outbreak of the war the merchant vessels under the British flag had an aggregate gross tonnage of 20,431,000 tons. The total losses of British vessels by war have been 609,934 tons. Germany's merchant fleet at the outbreak of the war aggregated 5,082,000 tons, and she has lost 34 vessels, with a total tonnage of 102,000. Norway has lost 30 vessels, of 47,000 tons aggregate, and France 24 vessels, of 42,000 tons. A more serious reduction in the world's merchant marine than even the losses of the war is the practical stoppage of merchant shipbuilding by the European nations involved in war. In 1913 the shipyards of Great Britain, France, Germany and Austria launched merchant vessels with an aggregate tonnage of 2,635,000. During the past ten months the shipyards of these nations have built very few merchant vessels, their energies being absorbed by naval work. Difficulties in obtaining capital, labor and materials also hinder ship-owners from ordering new ships.

Activated Sludge in America: An Editorial Survey

By M. N. Baker*

SYNOPSIS—Notes on a new process of sewage-treatment gathered by the writer on visits to the several experimental plants. Sewage is aërated in a tank in the presence of an accumulation of aërated sludge. There is reason to hope that a high degree of clarification and perhaps bacterial reduction, when necessary, with a stable effluent and a quick-drying sludge, high in fertilizing value, can be produced by this process alone.

To see for himself and for such of the readers of this journal as cannot see for themselves just what is being done in the way of activated-sludge experiments in various parts of North America, the writer recently visited all the known experimental plants of the kind this side of the Atlantic, except the one at faraway Regina and the aërated contact bed at Houston. His notes, revised and supplemented by correspondence almost to the date of publication, constitute a general survey of this new, interesting and promising method of sewage treatment.

The experiments at Washington, Baltimore (thus far), Chicago and Regina are on a small scale. Those at Urbana have small but numerous and well-controlled units. The Milwaukee units, a half dozen in number, range from glass tubes to tanks of over 20,000-gal. holding capacity and more than 60,000-gal. daily capacity, one of these large tanks being operated on the fill-and-draw and one on the continuous-flow plan. The Brooklyn tank has a holding capacity of 16,000 gal. The Brockton and Cleveland tanks are of fair size. The Lawrence tanks are relatively small. Some of the tanks at Lawrence and each one at Brockton and at Houston might very properly be described as aërated contact beds.

The activated-sludge process, thus far on the small-laboratory or at best the large testing-station scale, will soon be tried on a more regular everyday basis. First in the field will be Baltimore, with two of its new Imhoff tanks modified to operate on the activated plan. Milwaukee was to receive bids for a 2,000,000-gal.-a-day plant on July 22. A preliminary plan for a unit of a plant to treat the sewage of 160,000 people at Houston, Tex., is published herewith. Activated-sludge plans have been prepared for several British cities and are merely awaiting funds before they are put in execution.

The Activated-Sludge Process

What is the process which in a brief period has been taken up by British and American investigators and cities, the State of Illinois and the United States Public Health Service? It is a new form or variety of forced aëration of sewage in the presence of a considerable volume (tentatively 25 per cent.) of accumulated sludge, which has itself been aërated and is enlivened with oxygen and bacteria. The oxygen is supplied by forced aëration, by a blower or an air compressor. In the cruder experiments with tanks the air is distributed by means of perforated pipes, giving uneven distribution, pronounced boiling at the surface and doubtless much waste of air. For satisfactory distribution some form of porous plate, extending over a considerable area of the tank bottom, seems essential. The medium used in the installations showing most careful design and giving the most promising results are 12x12x1½-in. filtros plates. These, we are informed, are being supplied for experimental purposes at special prices by the manufacturers, the General Filtration Co., Cutler Building, Rochester, N. Y.

Just what the activated-sludge process will accomplish within economic limits remains to be settled. The strongest claims for it are that with a relatively small tank area the process will produce a stable, well-clarified effluent with a considerable degree of nitrification; a quick-drying unobjectionable sludge of high fertilizing value; and, if the aëration process be continued for a not prohibitive length of time, that the effluent will show a 99-per cent. bacterial reduction.

For many localities the activated-sludge process bids fair to be a self-contained flexible process, easily adapted to changes due to season, flood or drought, and a variety of other conditions liable to frequent change, and easily supplemented, if need be, by more or less rapid filtration, or by chlorine disinfection.

Many questions about the new process await settlement. The first and most important one—assuming that the process will give the purification results desired and promised—is: What will the process cost? Others relate to size and shape of tank, depth of sewage, method of air distribution, and whether the tanks should be operated on the fill-and-draw or continuous-flow plan. A critical question in some localities will be the effect of blowing in air at and below zero temperatures.

In view of the high promise of the new process and the many points regarding it still to be settled, it is desirable that all who are in a position to do so join in the investigations now being made. It goes without saying that careful records of all significant data should be kept, particularly relative volumes of air and sewage and all the elements of cost, and that an effort should be made to so keep the records that they may be readily compared with others, or at least be reduced to a comparable basis.

Laboratory Tests and Proposed Full-Size Activated Imhoff Tanks at Baltimore

Up to the time of my visit on June 4 only small-scale laboratory experiments had been conducted at Baltimore, but these were of a varied character, and it was expected that by July 15 two of the nearly completed Imhoff tanks would have been adapted to the continuous-flow activated-sludge process, and put into use.

The Baltimore experiments, as a result of a coöperative agreement between that city and the United States Public Health Service, are being conducted under the joint direction of Calvin W. Hendrick, Chief Engineer of the Baltimore Sewerage Commission, and Leslie C. Frank, Sanitary Engineer, United States Public Health Service.

*Editor, "Engineering News."

Mr. Frank was formerly at Baltimore in charge of the design of the new Imhoff plant. Gustav J. Requardt is now Acting Division Engineer in charge of the Baltimore Sewage-Treatment Works.

Mr. Frank has adopted the name "aëro tank" for the type of continuous-flow activated-sludge tank which he has designed, and into which two of the new large Imhoff units are being converted.[1] In operating these aëro tanks hydro-electric power from the fall of the treated sewage can be used to supply the necessary compressed air.

The new sanitary sewerage system and sewage-treatment works for Baltimore were placed in operation in 1911. The sewage is stale when it reaches the works, where it is treated by means of plain preliminary settling tanks, fine screens, sprinkling filters, and plain final or post-filter tanks. The sludge from both the preliminary tanks and the post-filter tanks goes to separate digestion tanks and thence to sludge-drying beds.

The laboratory experiments were begun in the early part of March, 1915. The purpose of these laboratory experiments was threefold: (1) To determine whether the English activated-sludge results on the fill-and-draw plan could be duplicated with Baltimore raw sewage; (2) to determine the best manner of initial operation of the large aëro tanks; (3) to determine whether the presence or absence of light bore any relation to the activated-sludge process. Determination (2) was considered important because it was Mr. Frank's belief that activated sludge might possibly be generated much more quickly in the large aëro tanks by the introduction of post-filter tank sludge than by the use of raw sewage alone or raw sewage and preliminary-tank sludge. He considered determination (3) advisable because, so far as known, all English experiments had been conducted in extremely shallow tanks or containers and it was possible that the effect of light due to this shallowness permitted forms of organic life to thrive which were an important element in the activated-sludge process, and which it might prove impossible to grow in the relatively deep aëro tanks at Baltimore because of insufficient light.

In carrying out the laboratory experiments air in unmeasured quantities was aspirated through five 2.5-liter bottles containing the following:

1. Stale raw sewage and post-filter tank sludge.
2. Stale raw sewage.
3. Sprinkling-filter effluent and post-filter tank sludge. (Light has been excluded from this bottle since about May 1.)
4. Fresh sewage (after a flow of one hour or less in an uptown sewer) and post-filter tank sludge.
5. Stale raw sewage and raw sewage sludge.

In a sixth experiment a propeller system of agitation and air comminution was being studied.

Experiments (1) to (5) were being run on the fill-and-draw plan. In the first several weeks of the experiments only enough of the supernatant liquor for analysis was drawn off. Then gradually more and more of the supernatant liquor was removed until finally all the liquor down to the sludge was removed four times per day.

Under date of July 11 Mr. Frank kindly summarized the results of his experiments as follows:

> Roughly, the experiments thus far have demonstrated that the activated-sludge process is possible with Baltimore sewage; that it is possible to generate activated sludge much more quickly with mixtures containing post-filter tank sludge than with raw sewage alone or with raw sewage sludge; that the absence of light does not seem to have an appreciable inhibiting effect. No difference could be observed in the rapidity with which activated sludge was generated in experiments (1), (3) and (4), all of which contained post-filter tank sludge. Post-filter tank sludge will therefore be used in starting the 40-ft. diameter modified Imhoff tanks.
>
> At lower rates of dosing than the four complete replacements per day referred to above, nitrates in the effluent were high. Four replacements per day produced relatively low nitrates. At this latter loading the oxygen demand of the effluent, however, is still very low, and the effluent compares very favorably in stability with sprinkling-filter effluent. The nitrogen in the activated sludge is high. The foregoing results compare favorably with the English results.
>
> Several of the experiments have now been discontinued, since, as previously indicated, the results from them practically duplicated one another.

Hygienic Laboratory, Washington, D. C.

From visiting the experimental work at Baltimore one naturally goes to Washington and rides out on a Pennsylvania Ave. car to the Hygienic Laboratory of the United States Public Health Service. There, under the eye of Prof. Earle B. Phelps, Leslie C. Frank is in charge of sewage investigations. As officially named, these investigations include at present sanitary privies for homes without water-carriage; sewage treatment for small communities and residences; the control and treatment of traffic sewage; activated-sludge and aëro-tank sewage treatment.

As part of the last-named investigation, and to supplement the joint experiments at Baltimore, Mr. Frank has been conducting a laboratory experiment since Feb. 17, 1915, on very fresh domestic sewage from two or three buildings. This sewage is three or four times as strong as that at Baltimore. The experiment was begun by filling a bottle with 80% raw sewage and 20% scum from the sludge chamber of the "small-community" Imhoff tank near the laboratory. This scum was in an entirely anaërobic condition and comparatively fresh. The container used for the experiment is a 4-liter bottle filled with 3.8 liters of liquid and sludge and provided with an inverted conical bottom. Unmeasured air is introduced into the bottle by aspiration.

In conducting the test only enough aërated sewage (500 c.c.) for analysis was removed daily at first. On Mar. 29 nitrification began, and shortly afterward the removal of aërated sewage was increased from 500 c.c. daily to 1000 and then to 2000 c.c. Finally, 2000 c.c. were removed twice each day; but as the results were poor a change was made to a removal of 1000 c.c. twice daily. The removal is again being increased gradually until the maximum posible loading of the device is determined.

The odor from the aërated sewage at both Baltimore and Washington is described by Mr. Frank as like that from forest mold. In appearance the effluent is very clear, often possessing a slightly yellowish or golden tinge.

On July 2 Mr. Frank reported that other experiments were being conducted to determine the relative effects of adding iron or manganese to the activated sludge, from the standpoint of what may be termed "bacteriological"—catalytic—action.

Milwaukee Sewage-Testing Station

Anyone who is investigating activated sludge should visit Milwaukee. The experiments there are varied, some of the tanks are large and the facilities for securing exact data are excellent. The tests are being conducted under

[1] On May 11, 1915, patent No. 1,139,024 (dedicated to the public) was granted to Mr. Frank for an invention relating "to the purification of sewage or other wastes by two known processes of sedimentation and oxidation combined in a new manner," carried on "continuously and simultaneously without interference one with the other." Copies of the patent may be obtained for 5c. each from the Commissioner of Patents, Washington, D. C.

the direction of T. Chalkley Hatton, Chief Engineer of the Milwaukee Sewerage Commission, with William R. Copeland as Chief Chemist and with Gilbert J. Fowler, of Manchester, England, as adviser.

Since the Milwaukee tests were described by Mr. Hatton in *Engineering News* of July 15, 1915, comparatively little need be said about them here. Two small glass tubes have been in nearly constant operation since March, 1915. A tank (Fig. 1) 10½x22 ft. in plan and 10 ft. deep was put in use on Mar. 26, 1915. On May 8, 1915, two inspection tanks, each 1x5 ft. in plan and 10 ft. deep, were started. All these tanks are operated on the fill-and-draw plan, but on June 21, 1915, a second large tank, working on the continuous-flow plan, was put into service.

The air for the tanks is supplied by a blower. Filtros plates are used for air distribution, except that in one of

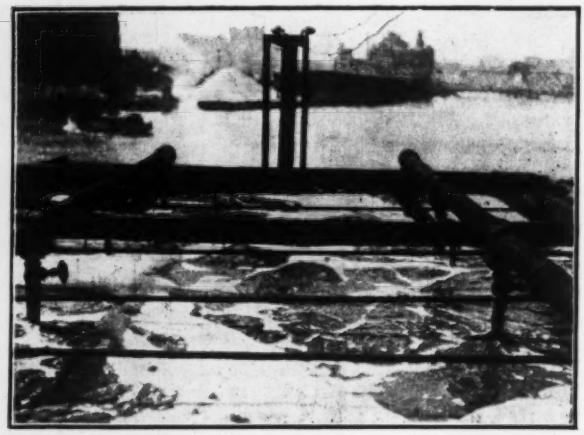


FIG. 1. ACTIVATED-SLUDGE TANK AT MILWAUKEE
Shows main air-supply pipes and top surface of sewage

the small tanks the air is admitted through a single pipe outlet. Ice bags will be suspended in the small inspection tanks to lower the temperature of the sewage.

The writer visited the Milwaukee sewage-testing station on June 10, 1915. He noted the quick-settling, granular, brown suspended matter and but slightly odorous character of both the sludge and the aërated sewage. He was informed that no attention has yet been paid to the fertilizing value of the sludge.

Bids for constructing a 2,000,000-gal. continuous-flow activated-sludge plant at Milwaukee were to be received on July 22, 1915. The contract form provides that the work shall be completed by Nov. 15. The object of this provision is to make it possible to get the plant primed before winter sets in, in order that the tanks may be operated in winter to determine the effects, if any, of low temperatures upon the process.

Stockyards Tests, Sanitary District of Chicago

Early in May, 1915, experiments at the Chicago Stockyards were begun by the Sanitary District of Chicago under the direction of Langdon W. Pearse, Division Engineer, and Arthur Lederer, Chemist. The stockyards sewage is seven or eight times the strength of ordinary domestic sewage. It is being treated in two galvanized-iron tanks, each 2 ft. in diameter and 10 ft. deep, operated on the fill-and-draw plan. One tank receives air at the rate of 0.1 and the other at 0.2 cu.ft. per sq.ft. of tank surface per min. The indications at the time of my visit on June 12 were that at least 0.2 cu.ft. of air would be required. The air is metered at a pressure equivalent to 8 ft. of water. It is supplied by a blower.

Sketch plans have been made for converting the Dortmund tank at the Stockyards Testing Station into an Imhoff aëration tank (continuous flow). It is also under advisement to convert some of the experimental tanks at the old Sanitary Testing Station at 39th St. into activated-sludge tanks. One sludge-digestion tank may be converted into a continuous, horizontal-flow aëration tank. An old roughing filter may be remodeled on a fill-and-draw plan. Up to July 6 it was not sure that the necessary funds could be secured for these additional experiments.

Illinois State Water Survey, Urbana

Like Milwaukee, Urbana is a place which should be visited by anyone who wishes to get knowledge and enthusiasm about activated sludge. Here the new process is being studied in minute detail from numerous scientific viewpoints, including the agricultural.

The experiments at Urbana were begun on Nov. 2, 1914, in 3-gal. glass bottles. On Jan. 4, 1915, a 9x9-in. wood tank, with glass windows front and back, was put in use. A filtros plate was placed 4 in. from the bottom of the tank. The working sewage depth was 3 ft. 7 in.

On May 5, 1915, two concrete tanks went into service. Each tank is square in plan, with an area of 10 sq.ft. and a depth of 8 ft. The sewage depth is about 5 ft., and the utilized holding capacity is 400 gal. per tank. In the bottom of each tank there are 9 sq.ft. of filtros plates for air distribution. On July 6 two more concrete tanks, of the same dimensions as those just described, were put in use. One of these has a filtros plate or air-diffusing area of 3 sq.ft. and the other of only 1 sq.ft.

The air for all the experiments has been supplied from the University of Illinois compressor plant, reduced from about 80 to 8 lb. All the air used is metered.

The earlier experiments at Urbana were described in *Engineering News* of Apr. 1, 1915 (p. 647). At the time of my visit on June 12, 1915, about 1 cu.ft. of air per gal. of sewage treated was being used, and the first two concrete tanks were being operated four cycles a day.

The sewage used in the experiments is a quite fresh average domestic sewage. For the bottle and 9-in. tank experiments the sewage was brought in 5-gal. carboys from the nearby Champaign trunk sewer; but the concrete tanks are supplied by pumping from the same sewer. All the experiments have been conducted indoors.

Drying beds for the sludge from the four concrete tanks were put in operation about June 20, 1915. Tests are to be made of a sludge-drying device which acts on the principle of a Robacher wheel. Filtros plates form the compartments of this wheel. Through these plates a vacuum may be applied to exhaust moisture from the sludge, and then pressure may be used to discharge the sludge.

Following the advice of Dr. Gilbert J. Fowler, of Manchester, England, the aim is to secure and retain in the tanks from 25 to 33% of activated sludge.

Notable features of the Urbana experiments are the studies being made of the biological condition and of the fertilizing value of the sludge. This value is shown both by analyses and by controlled plant cultures.

The experiments are being conducted under the direction of Prof. Edward Bartow, Director of the Illinois

State Water Survey, by F. W. Mohlman, W. D. Hatfield and Robins Russell. A. N. Talbot, professor of municipal engineering at the University of Illinois, was adviser in designing and constructing the new concrete tanks.

Cleveland Sewage-Testing Station

On May 5, 1915, an outdoor tank, 5x10 ft. in plan and 5 ft. deep, on the activated-sludge plan, was placed in service at Cleveland, and at the date of my visit (June 15, 1915) an indoor tank 17½ in. square in plan by about 5 ft. of sewage depth was being made ready. These were both fill-and-draw tanks, of wood, with flat bottoms.

The activated-sludge experiments at Cleveland are being conducted at the old sewage-testing station on the lake front.[2] The large tank was formerly a roughing filter. To convert it into an activated-sludge tank the old filter gravel was thrown out and the manifold system used for air distribution. This system consists of a central pipe 8 in. in diameter, with 2-in. branches, 6 in. c. to c. The branches were perforated with holes about $\frac{3}{16}$ in. in diameter, spaced 6 in. c. to c. Air was being supplied at the rate of 3 cu.ft. per min. for the whole tank, or 0.05 cu.ft. per min. per sq.ft. of tank bottom.

If necessary, at any time, compressed air may be stored in a tank. All the air used is metered and likewise the electric current which drives the motor. Reducing valves maintain a constant flow of air to the sewage which is being aërated.

The air distribution in the outdoor tank has been uneven. The unevenness or somewhat violent boiling shifts from side to side, suggesting that some of the perforations in the air pipe may, at times, be stopped up. To offset this condition it has been found advisable to shut off the air for a short period and then release the same. This method of procedure, on account of the additional pressure, creates a violent bubbling and stirring action.

At first, difficulties with the compressor interfered with a continual operation of the plant. However, on May 18 the large tank was placed in operation on the fill-and-draw plan, and has been working ever since. The tank was aërated for a week without drawing off any of the supernatant liquid. This aëration period was then reduced to three days for two weeks and since then it has been increased to one week.

The sewage used for the tests is distinctly stale. The question has arisen whether this would materially affect the process being tested. The suspended matter in the treated sewage settles rapidly, as at other places. From a putrescibility standpoint, the treated sewage stood up for 3½ days. Up to June 15 no nitrification had been secured.

The indoor tank is being used to study air distribution and to secure cost data. A satisfactory air distribution was not secured until a filtros block was used for the purpose. First a 2-in. layer of sand held in a box between fine screens was tried. The sand streaked and gave no uniformity. On substituting a perforated tin plate the air appeared at the surface in large bubbles and unevenly.

After securing some activated sludge in the two tanks described, the intention is to fit up another wooden tank, about 6 ft. in diameter and in height, and operate it on the continuous-flow plan. This tank will be located on the lake edge and filled directly from the settling-tank chamber without pumping.

Robert Hoffman is City Engineer of Cleveland. The tests just outlined are under the direction of R. Winthrop Pratt, Consulting Engineer on Cleveland Sewage Disposal, and in immediate charge of George B. Gascoigne, Assistant Engineer.

Plain and Activated-Sludge Aëration at the Brooklyn Sewage-Testing Station

A large outdoor sewage-aëration tank of unique design, originally installed to conduct experiments similar to those carried on at the same site by Black and Phelps in 1910-11, was changed to the activated-sludge plan about the middle of March, 1915. Bottle experiments have also been conducted here.

The tank is of wood, 12 ft. in diameter, 25⅔ ft. high, with a sewage depth of about 22 ft. and a holding capacity of 16,000 gal. Compressed air is admitted at the bottom through a grid of pipe perforated with $\frac{1}{16}$-in. holes, 6 in. c. to c. To get additional diffusion of the air this grid is placed midway in a 15-in. bed of gravel. In addition, on its upward way the air passes through nine equal-spaced horizontal disk deflectors, composed of inclined slats of wood. These deflectors are also designed to prevent streaming of the sewage in its downward passage through the tank. Originally the aërated sewage was taken out at a point 1 ft. above the top of the gravel bed; but since the activated-sludge experiments were started it has been drawn out at a point about one-third up, so as to remove 10,000 gal. of the clearer liquor and leave 6000 gal. of sludge and sewage.

The tanks are aërated 22½ hr. out of the twenty-four. The schedule is as follows: Air off from 8 to 10:30 a.m., with sewage being drawn from 9 to 10:30 a.m.; refilling, with air on, from 10:30 a.m. to 12 m. Air is applied at the rate of 1.17 volumes of air to 1 volume of sewage (full-tank basis) treated.

The writer observed the tank on June 21, 1915. Notwithstanding the means of air distribution already described, there was a decided boiling on a third or more of the area of the tank. Samples of the top liquor become well clarified after a brief period of sedimentation.

A small aërated contact bed has also been tested at Brooklyn.

E. J. Fort is Chief Engineer and George T. Hammond is Engineer of Design of the Bureau of Sewers, Borough of Brooklyn.

Cascade Aërator and Continuous Multiple-Contact Bed at Brockton, Mass.

Instead of using an air compressor to force air through sewage under a considerable head, R. S. Weston, Sanitary Engineer, Boston, Mass., decided to try the more efficient centrifugal pump to lift and relift the sewage itself under a very low head to a cascade aërator over which it would flow in a thin air-exposed sheet to and through a tank nearly filled with cobblestones.[3] The effluent from the "Brockton tank," as Mr. Weston has named it, goes to an Imhoff tank, and the effluent from this goes to a sprinkling filter.

Twenty years ago Brockton built sanitary sewers, a receiving reservoir, a pumping station, a 3-mile force

[2] See "Engineering News," Feb. 13, 1913. For the present, the new tests will be carried on with the tank and apparatus at hand, so certain details which might affect the results are lacking. Tests formerly conducted at this station with sludge from Imhoff tanks make it particularly desirable to run similar tests with activated sludge.

[3] Similar to the Clark tank at Lawrence (described further on), but with the slate replaced by cobbles.

main and intermittent sand filters. Since then more sand filters have been built, and a Weand rotary screen and sprinkling filters have been put in; but the sand filters are still overtaxed and the sprinkling filters do not operate satisfactorily.

The sewage is strong, contains wastes from the leather and shoe industries, and is very stale when it reaches the disposal works, some of it 15 mi. from the point of origin. At the pumping station the sewage is only 13 to 15 per cent. saturated with dissolved oxygen, which disappears when the sewage is delivered through the force main at the sewage works. The deficiency in oxygen is a great disadvantage, especially in winter. The Brockton Sewerage Commission recently employed Mr. Weston to report on improvements to the works. In his experiments he is working in coöperation with Benjamin R. Chapman, City Engineer, and Frank E. Kennedy, Superintendent of Sewage Beds.

The tank is of wood, 10 ft. square and 10 ft. in maximum depth, and has a holding capacity or detention period of five hours, the same as the Clark tank at Lawrence. On a false bottom there is a bed of 6-in. cobblestones, 6 ft. in depth, above which the sewage stands to a depth of 12 in. There is a shallow chamber with a sloping bottom which gives a depth of 0.5 to 2 ft.

A stream of sewage is continuously discharged over the aërator and into the tank. A centrifugal pump takes sewage from the bottom of the tank for reaëration and discharges it back into the orifice tank and then to and over the aërator. At the same time a portion of the treated sewage is flowing by gravity from the base of the "Brockton tank" into the bottom of the Imhoff tank. At the time of my visit (June 25, 1915) the sewage was being passed over the aërator and through the tank twenty times.

FIGS. 2 TO 4. VIEWS AT THE EXPERIMENTAL PLANT, BROCKTON, MASS.

Fig. 2—"Brockton tank," with orifice and weir boxes and cascade aërator in middle distance; Imhoff tank in foreground. Fig. 3—Weir box and cascade aërator. Fig. 4—Superintendent Hornaday and the Editor being snapshotted by Mr. Weston

At the experimental plant (Fig. 2) sewage "supposed to be fine-screened" is delivered into an orifice box about 2x3 ft. in plan and 1 ft. deep. From this it flows through a calibrated orifice to a small weir box and over a weir about 18 in. long on to the cascade aërator. This aërator (Fig. 3) was made of corrugated sheet iron, with the corrugations at right angles to the sewage flow. It is about 2 ft. wide, has a slope of 1 ft. vertical to 10 ft. horizontal and has a total length of about 20 ft., secured by placing it along two sides of the tank which receives the aërated sewage. The sewage flows down the aërator in a thin sheet and is well broken up by the corrugations.

The Imhoff tank (foreground of Fig. 2) is of galvanized sheet iron, 5 ft. in diameter and 6 ft. high, with 4½ ft. of sewage depth. The settling period is 2 hr.

Two sludge beds of sand, each 5 ft. square, receive the Imhoff-tank sludge.

The sprinkling filter is built of broken stone with rubble wall It is 12 ft. in diameter and 6.5 ft. deep. It is a replica of one sprinkler unit of the nearby municipal filter.

On one of the preliminary runs fine-screened sewage was aërated continuously for 15 days. A nitrification of 2.5 parts (nitrates) per 1,000,000 was secured. This subsequently decreased, but was not altogether lost. At

the time of my visit the plant had been operated since June 6, 1915, on the continuous plan already described. To that date the oxygen consumed (required oxygen) had been greatly reduced, the nitrites largely increased and there had probably been a slight nitrification. The sprinkling filter effluent showed nitrification.[4]

There was a finely divided gray scum, less than 0.5 in. thick, on the "Brockton tank," but no scum on the Imhoff tank. Samples of top liquor from the "Brockton tank" showed to the eye considerable finely divided suspended matter, but unlike the suspended matter in activated-tank top liquors. There was little odor to the samples from either tank. A cobblestone lifted from the first tank was well covered with a blackish sludge. It was said that fly larvæ appear in the "Brockton tank"; also tubifex, one of the scavenging worms.

Under date of July 12, 1915, Mr. Weston sent the writer the following supplementary facts and comments:

> The Brockton experiments are being made to determine the relative value of aëration and contact with the accumulations of sludge on a contact surface, as suggested by Clark and others, and as compared with the activated-sludge method as suggested by Fowler and others—i.e., aëration with fixed and with moving sludge respectively. The method of aëration by pumping over a cascade is being tried. A trial of aëration with compressed air, using filtros plate for distribution, is being considered. After the completion of the experiments with the cobbles they will be removed and the tank used as a continuous activated-sludge tank.
>
> The height of 40 ft. for pumping the sewage will, of course, make the air blower the cheaper machine. We are starting, however, with the extreme amount of aëration which is possible with the devices as constructed, and hope that this can be gradually reduced.

Aërated Slate and Activated-Sludge Tanks at the Lawrence Experiment Station

Like so many other innovations in sewage treatment, the activated-sludge process was suggested by experiments carried on at Lawrence under the direction of H. W. Clark, Chemist of the Massachusetts State Board of Health. It was here in 1912 that Gilbert J. Fowler, of Manchester, England, renewed his interest in sewage aëration to such an extent as to lead him to undertake experiments of his own on his return to England. The results of these experiments by Fowler, and also by others in England, came back over the Atlantic in such form as to cause the starting up of activated-sludge experiments in the United States and Canada in and since the latter part of 1914.

Just what Dr. Fowler saw at Lawrence and Mr. Clark's view of its relation to the early stages of the activated-sludge process may best be stated in Mr. Clark's own words:

> He [Dr. Fowler] visited the station in August, 1912. At that time we had been carrying on bottle experiments upon aëration for four months, as explained in the reports on the Lawrence work [Massachusetts State Board of Health] for 1912 and 1913. In these gallon-bottle experiments, in which aëration was kept up continuously, we produced stable sewage and high nitrification. The bottles were emptied daily and filled with fresh sewage, allowing only what we designated as "growths" on the sides and bottoms of the bottles to remain. By means of these "growths" and aëration, we day after day produced stable and highly nitrified bottle effluents. This was the work shown to Dr. Fowler in August, 1912. On returning to England he began exactly similar experiments [except that he retained sludge in the bottle], but instead of calling the algal life and other life in the bottle "growths," as we designated it, he gave it the more taking name of "activated sludge."

[4] A letter from Mr. Weston states that the nitrification was 1.1 parts per million on July 6 and 2.2 parts on July 9.

Meanwhile at Lawrence attention was directed to sewage aëration in tanks containing slate—called for convenience aërated slate tanks. The slate were thin. At first they were placed vertically, but for the last two years they have been in a horizontal position. During the present year activated-sludge experiments have also been carried on at Lawrence.

Visiting Lawrence on June 28, 1915, I first noted three slate tanks. These are small rectangular tanks of galvanized iron, with a sewage depth of about 3 ft. Two have a capacity of 200 gal. each and one of 168 gal. If the slate in the tanks were packed solidly it would occupy respectively 10, 3.5 and 1.75 per cent. of the space. The sewage is aërated for 5 hr., at the rate of 50,000 cu.ft. of air per hr. per 1,000,000 gal. of sewage. After aëration the sewage is drawn off down to the sludge, the tank is refilled, and aëration is resumed. Through the night, aëration is discontinued, as the mechanical plant at the Lawrence station is operated only 12 hr. a day.

Air is supplied to the bottom of the tanks by a blower. One tank has two air inlets; each of the others has one inlet and an air deflector.

The aërated slate tanks give a stable effluent 90 per cent. of the time, and always produce a stable sludge. The original sewage, it may be added, from combined sewers, is fairly strong.

Activated-sludge tanks have been in operation at Lawrence since February, 1915—in addition to the bottle experiments with aëration and "growths" already mentioned, begun in April, 1912, and continued to date. Two small tanks are in use. One is of galvanized iron, 26 in. in diameter and 48 in. high, and is filled nearly to the top. The other tank is of wood—a small barrel. Metered air is admitted to the bottom of each tank through a single inlet, at the rate of about 250,000 cu.ft. per hr. per 1,000,000 gal. of sewage, or five times the rate for the aërated slate tanks.

Mr. Clark states that the same general results are being obtained with the activated-sludge tanks at Lawrence as elsewhere, but that he is more interested in the aërated slate tanks, which give better results at less operating cost for air. The Lawrence activated-sludge tanks give a quick-settling stable liquor, without nitrates, and a stable sludge.

Both kinds of tanks at Lawrence are indoors. The sewage treated in them probably never goes below 48 deg. F. Equally good results appear to have been obtained with the lower as with the higher temperatures, but it is not known how low the temperatures could go and still give good results.

It is interesting to note that the effluent from the aërated slate tanks has been successfully treated by a sprinkling filter at the rate of 9,000,000 gal. a day, applied during a period of 22 hr.

Experiments at Regina

While at Chicago the writer heard that activated-sludge experiments had been conducted at Regina, Sask., under the direction of R. O. Wynne-Roberts. Regina was too far afield to warrant a visit, but the *Canadian Engineer* of July 1, 1915, contains a description of the Regina plant written by Mr. Roberts. The following statements are from that source.

Two indoor galvanized-iron tanks, 4 ft. 7½ in. in diameter, with a 2-in. central outlet pipe in their bottom

and a long, narrow glass window in their side, were provided. The sewage depth was about 5½ ft., giving about 700 U. S. gal. of sewage per tank.

The tanks were filled with raw sewage. Aëration was started in No. 1 on May 18 and in No. 2 on May 20, 1915. After two days' aëration a "pailful of concentrated sewage from houses" not yet connected with the sewers was poured into each tank. Subsequently the process was "repeated about seven times." What happened still later is not stated.

Air was supplied to Tank 1 by means of an improvised air compressor and receiver through pipe in the bottom of the tank. Perforations 6 in. c. to c., covered with canvas, served as air diffusers. The size and arrangement of the air pipes and the size of the perforations are not given.

The air supply for Tank No. 2 was secured by an improvised and apparently unsatisfactory injector, which discharged a mixture of sewage and air at the top of the tank with such force that it was driven nearly to the bottom of the tank, where it was spread out to the side of the tank by striking an inverted cone.

The air delivered to each tank was measured by a ⅜-in. orifice plate inserted in the air pipe, with a connection from either side of the plate to a water gage. The aim was to supply air at the rate of 0.25 cu.ft. per min. per sq.ft. of tank area.

Mr. Roberts' connection with the experiments closed on May 31, when they were taken in charge by F. A. McArthur, City Engineer of Regina. Andrews and Cruckshanks were employed to make analyses, but at the time Mr. Roberts wrote, full results were not available.

Settling and Aërated Contact-Bed Experiments at Houston, Tex.

Present indications are that Houston, Tex., will be the first city to treat all its sewage by the activated-sludge process. However that may be, it seems worth while to relate briefly how E. E. Sands, City Engineer of Houston, experimented for four months with sedimentation and the treatment of the settled sewage in an aërated contact bed and by electrolysis, and then, after visiting a number of places where experiments with activated sludge are being carried on, decided that this new process was just the one to meet conditions at Houston and began to design works to treat the sewage of 160,000 people, including residents of some suburbs.

Houston has a strong sanitary sewage, which is more or less septic when it reaches the pumping station. In the experimental plant this sewage first went to a settling tank 6 ft. wide, 20 ft. long and 5 ft. deep, from which sludge was removed to prevent septic action. The tank was operated on the fill-and-draw plan. The settled sewage was measured by a weir.

The aërated contact bed was a tank 5 ft. square and 3.55 deep, filled practically to the top with 1½ to 2-in. broken limestone and settled sewage. The stone had 42 per cent. of voids, giving a sewage-holding capacity of 270 gal. A small air compressor, driven by a ¼-hp. induction motor, supplied air at the bottom of the tank through three ½-in. pipes, each perforated with five ⅛-in. holes. A gas meter and a mercury U-tube showed the amount and pressure of the air supply. At first the air had a tendency to go up through two or three orifices. A relief valve was put on and the compressor speeded up, after which a better distribution was secured. An air pressure of 81 in. of water was required to force the air through 42 in. of sewage. This is thought to have been due to partial stoppage of the pipe perforations by the stone. The aërated tank or contact bed was operated on the fill-and-draw plan.

Average stability results under the conditions stated are shown by the accompanying table.

SEWAGE AËRATION RESULTS AT HOUSTON

Settled, Hr.	Aërated, Min.	Cu.Ft. of Air per Gal.	Relative Stability
2	20	0.6	41
2	30	0.9	46
2	40	1.2	70
2	50	1.5	78
2	60	1.8	88
2	90	2.7	99

Aëration for more than 90 min. showed but little further improvement. It was not unusual, Mr. Sands states, for the aërated effluent to stand up 40 to 45 days or more. An oxygen-consumed test showed 351 parts per 1,000,000 in the raw sewage and 10 parts in the aërated sewage.

The electrolytic tank or flume, similar to the one at Oklahoma City, was 22 in. wide, about 14 in. deep, and 30 ft. long. It was filled with vertical plates about 1 in. apart supplied with electric current at 4 volts and 150 amp. (sometimes 5.8 and 315 respectively). Sewage settled for various periods was passed through the electrolytic flume at the rate of 27,000 gal. a day, but no "consistent results" were obtained. Crude sewage with 351 parts per 1,000,000 of oxygen consumed, which after being settled 2 hr. and aërated in the contact bed for 2½ hr. showed only 10 parts per 1,000,000 of oxygen consumed, showed 78 parts after the same sedimentation

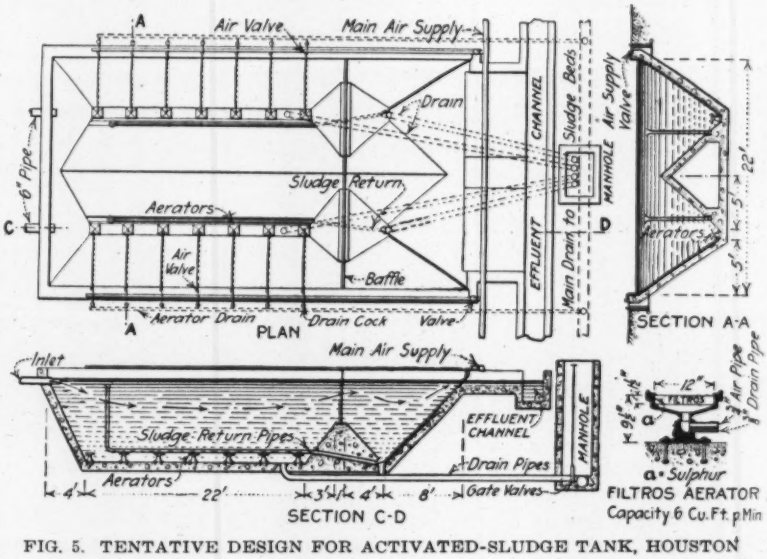


FIG. 5. TENTATIVE DESIGN FOR ACTIVATED-SLUDGE TANK, HOUSTON

The holding capacity of the aërating tank is 2850 cu.ft.; of the upper part of the settling tanks, 761 cu.ft.; of the lower part of the settling tanks, 156 cu.ft. The aërating period is 75 min. The inflow of raw sewage is at the rate of about 226 gal. per min. and the return flow of sludge at the rate of about 57 gal. per min. The settling period in the upper part of the settling tank is 20 min. The required volume of air (compressed) is 84 cu.ft. per min., not including that for the sludge-return pipe

period, followed by electrolytic treatment at 4 volts and 150 amperes. The same electrolytic effluent, after being aërated for 6 min. in an open barrel, showed 63 parts of oxygen consumed.

The conclusions drawn by Mr. Sands from his experiments were that the electrolytic process was too uncertain to warrant further consideration and that the aërated contact bed supplied with settled sewage indicated that "a first-class effluent may be obtained by a plant occupying a relatively small area, and without creating any nuisance, but that the cost of operating such a plant would be comparatively high."

PROPOSED ACTIVATED-SLUDGE PLANT AT HOUSTON

After making a trip to Milwaukee and other sewage-experiment and sewage-disposal plants Mr. Sands decided late in May, 1915, that the activated-sludge process would solve the sewage problem of Houston.

The Houston effluent will be discharged into a navigable stream which is not used for water-supply purposes, so only nuisance prevention need be considered. Ordinary sewage-treatment works would require pumping of the sewage several miles under a considerable head, which would be avoided with the activated-sludge process.

On June 30 Mr. Sands sent *Engineering News* his preliminary design (Fig. 5) for a unit of an activated-sludge plant for Houston. He states that the design is liable to change before he begins construction, and that meanwhile criticism would be welcome.

Coarse screens and grit chambers will be installed at the pumping station. The disposal plant consists simply of electrically operated blowers, activated-sludge tanks and perhaps sludge-drying beds.

Mr. Sands considers as settled that to meet Houston conditions aëration for from 60 to 75 min. followed by settlement for from 15 to 20 min. will be sufficient. He also believes that "a return rate of from 20 to 25% in the sludge pipe will keep a sufficient amount of activated sludge in the aërating tank to produce first-class results." He is in doubt as to the best means of controlling the sewage flow in the tank and of returning activated sludge to the tank, and is not satisfied that filtros blocks will be the best medium for air diffusion. He is making experiments to clear up some of these doubts.

What is "Vitrified" Brick or Pipe?

The original meaning of "vitrified" is "made glassy," and in this sense few, if any, ceramic products are vitrified.[1] On account of the differing characteristics of different clays, the best degree of burning is variable, and the resulting appearance also varies. Often a product of more "glassy" appearance than another is less serviceable. There is no uniform meaning applied to the word "vitrified" as commonly used. An analysis of the several effects of burning clay wares leads Prof. Edward Orton, Jr., of Columbus, Ohio, in a paper presented to the recent annual meeting of the American Society for Testing Materials, to conclude that the most useful measure of burning may be determined from the absorption, interpreted as an index of resulting compactness. He proposes the following definition:

> Where the word "vitrified" is used in a contract or agreement in describing the properties of a clay product, and is not further defined in the contract, it shall mean that the product shall have attained in the firing process such a degree of compactness that its mean absorption does not exceed 3 per cent. of its own initial weight of pure water, when subjected to complete immersion in cold water for 48 hr. or boiling water for 3 hr. Not less than three tests shall be made in determining the mean absorption, and no single test may exceed the mean by more than 0.5 per cent. Neither the possession of the visual properties or appearance of a glass nor any definite degree of physical strength, hardness, color or specific gravity shall be implied as an attribute of vitrification.

The proviso that this definition applies only where the contract gives no definition is important. If vitrified paving brick of 5 per cent. absorption gives good service (Mont Schuyler, St. Louis, Mo.), the specification should set limits including this value[2] and the definition is not intended to apply.

Overhead Line Construction

In a paper presented before the recent meeting of the National Electric Light Association at San Francisco, J. C. Martin described the difficulties of electric development in the Pacific Northwest where the requirements of the association's specifications had been embodied in acts and orders. He contended that the construction advocated was well adapted only to Eastern conditions. In the West, distribution at pressures up to 15,000 volts or more is necessary because of sparse population. The construction required for that voltage under the specifications was prohibitive in cost.

A dispute arose in comparing oil switches with air-break switches, but no important conclusion resulted. It was agreed that oil switches give less trouble generally, but that in cases where air-break switches satisfy they are just as good. One member stated that there is now an instrument for locating inductive interferences, and that it had been successfully used. If the inductive interference of the two lines can be localized, it is believed that the trouble can be remedied and that the power companies can be saved the present annoyance and expense of shifting their poles at the bidding of the telephone companies.

Unnecessary Underground Piping in the streets of the Borough of Manhattan, New York City, was described in a report recently made by Charles N. Green, engineer of subsurface structures for the Public Service Commission, to Chief Engineer Craven. In the construction of the subway, which makes necessary the removal of underground piping, the commission is obliged, after the subway itself is constructed, to relay all pipes that have been displaced, including duplicate and unused pipes, as well as those now required for service. It is estimated that the cost of relaying these unnecessary mains is from $2000 to $15,000 on each subway contract section. Mr. Green estimates that there are approximately 1450 mi. of gas mains in the Borough of Manhattan on about 500 mi. of street, and about 800 mi. of water mains, not including the 100 mi. of high-pressure mains. There is no reason why the mileage of gas mains should be greater than the mileage of water mains, except that a considerable part of the mains was originally laid by separate and competing companies. Mr. Green estimates, therefore, that there are at least 500 miles of unnecessary gas mains occupying space beneath the street surface which is badly needed for other underground conduits. The city derives little revenue from these underground pipes in its streets, as most of them were laid many years ago under perpetual franchises.

[1] The new standard definitions of terms relating to sewer pipe of the American Society for Testing Materials define "vitrification" as "fusion into a hard glassy material under high heat."

[2] The new standard specification for paving brick of the American Society for Testing Materials does not specify absorption, but judges the brick exclusively by appearance and by rattler test.

Field and Office

Flume Without Side Braces

In the construction of the City Trunk Line, by means of which the municipality of Los Angeles receives its apportionment of the Los Angeles Aqueduct, flume work is employed in the crossing of a shallow creek bed. The flume erected differs from the standard form of flume construction in that no outside struts or braces were employed.

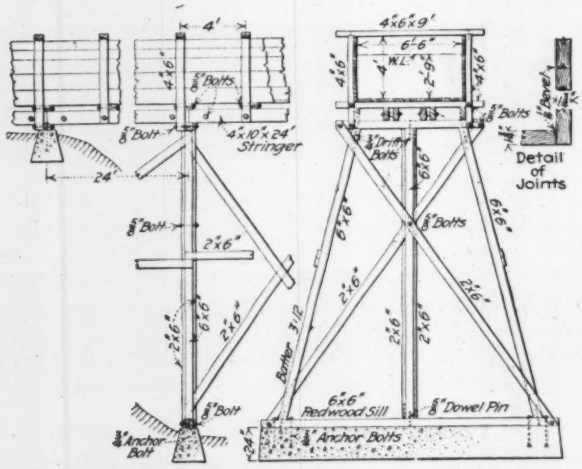


FIG. 1. DETAILS OF FERNANDO FLUME, LOS ANGELES WATER-WORKS

The flume has a total length of 676 ft. and is designed to carry a flow of 20,000 miner's inches (approximately 258,000,000 gal. per 24 hr.) at the high velocity of 22 ft. per sec. The grade is 2.58 per cent. The allowance for n in Kutter's formula was 0.011. The structure is built

FIG. 2. VIEW OF FERNANDO FLUME, LOS ANGELES WATER-WORKS

on a tangent and carries the full flow of the aqueduct 18 ft. above the creek bottom.

The flume proper is built of 2-in. redwood plank, sized on one side, calked with oakum, with inside dimensions of 6½ ft. in width and 4 ft. in depth, with an allowance of 15 in. for freeboard.

Since the usual side struts were considered likely to loosen and weaken the structure, the side walls are held firm by bolting the outside posts to both the cap of the bent and the cross-tie under the flooring and by employing a 4x6-in. cross-tie doweled in at the top (see Figs. 1 and 2).

The bents are of selected Oregon pine, set 12 ft. apart, on concrete foundations, except over the stream bed, where there is a truss with the end bents placed 48 ft. apart to permit the passage of drift in winter freshets. The cost complete amounted to $7.50 per lin.ft.—From Burt A. Heinly, 645 South Olive St., Los Angeles, Calif.

New Rope-Testing Machine

A continuous rope-testing machine recently placed on the market consists of a series of four revolving grooved wheels, which grasp the rope in such a way that for about 8 ft. of its length it is subjected to a known tension. Two forward sheaves and a coiling frame are driven by a motor, while the rear pair are restrained by a friction brake. The tension can be regulated by a lever, which

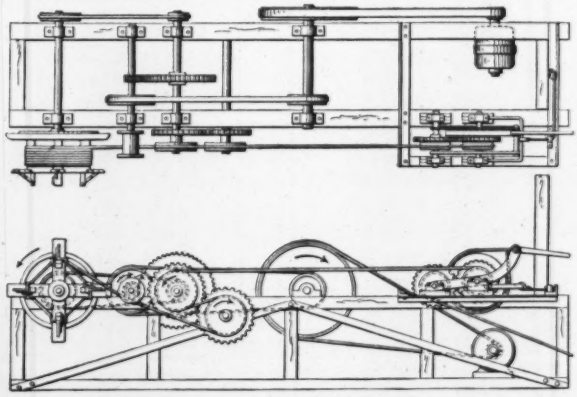


FIG. 1. PLAN AND ELEVATION OF NEW ROPE-TESTING MACHINE

acts on the friction brake. The rear sheaves and brake are mounted upon a sliding carriage, which is connected with a weighing device for measuring the tension in the rope. Special provision is made for testing the extreme ends of a rope. An end is looped over a hook, after the body of the rope has been tested, and a momentary pull is exerted upon the end. The accompanying plan and elevation illustrate the design of this machine. For the photograph of the machine in operation we are indebted to the New York Edison Co.

It was invented by A. N. Faulkner, secretary of the Chesebro-Whitman Co., 64th St. and First Ave., New York City. This company proposes to lease these machines as soon as it is in a position to produce them in sufficient quantity. Mr. Faulkner states that he intends to build another machine for testing steel cables. The

present machine is adapted especially for testing rope used for rigging work. He also proposes to build a machine on the same principle as the present one for testing chains,

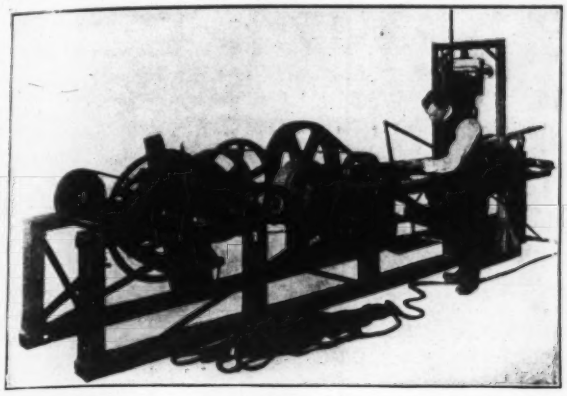


FIG. 2. ROPE-TESTING MACHINE

and has applied for a patent on the chain-testing machine. About 400 ft. of manila rope can be tested by the present machine in 10 min.

Erecting New Trusses on a Canal Bridge and Dam

By W. R. Browne*

Part of the work necessary for the strengthening of the New York State Barge Canal bridge[1] at Dam 5 near Rotterdam Junction consisted of erecting a new truss on the downstream side of each of the three spans, centered 2 ft. outside of the present downstream truss. This work was made difficult by the limited working space available (Fig. 1), due to the necessity of keeping the track clear for the passage of the steam hoist used in operating the wickets and gates of the movable dam. The track itself proved a help, in that it provided for the use of flat cars for running the iron out to its position, and a niggerhead on the hoist was used for a runner or with the falls on a ginpole, as each in turn was required.

The lower-chord members of the new truss were placed with a set of falls attached to the upper chord, while a light latticed steel ginpole served to place the remaining members of the trusses. The members were swung up to the bridge at the west approach, landed on flat cars, and run out to their respective positions as required.

Since the steel was unloaded at the shore end of span 1, it was planned to erect first the truss in span 3 and back away from the work, clearing up the bridge as the work progressed. Here, however, a change was made, since it was found impossible to complete the reinforcing on the upstream truss of span 3 in time to allow the start of the new truss on that span without laying off part of the gang. The direct causes for this condition were, first, the nature of the reinforcing on the upstream truss was such that only a few men could be used; and, second, the state would not permit the increase of dead-load caused by the erection of the new truss until the upstream truss reinforcement was completely driven up.

*Fort Trumbull Beach, Milford, Conn.

[1]For description of the movable dam and bridge used on the Barge Canal, see "Engineering News," May 27, 1915, p. 1034.

For these reasons the trusses in spans 2 and 1 were erected, in the order named, and jacked onto the shoes to clear the track before the last truss was started. This program caused less inconvenience than was thought probable, but incurred a slightly greater expense, in that the same ground had to be covered twice.

As previously mentioned, when completed and in position, the new trusses were to be centered 2 ft. outside the old trusses; but it was necessary to erect them outside of the final position to permit connecting and riveting. In order that the trusses might retain camber during erection, a set of camber blocks was made from rounds of the proper diameters. Since $\frac{7}{16}$-in. bearing plates for the new trusses were riveted to the floor-beams, and the blocking must necessarily clear the final position of the truss, the rounds used at the different panel-points were $\frac{7}{16}$ in. greater in diameter than the difference in camber required.

The trusses having been completed in their temporary positions on the blocking, the top chord was pulled into line by means of four sets of double falls. The bottom chord was then jacked into position by means of six Norton jacks—one at each shoe and one at each L_2 and L_5 panel. Blocking placed against the inside rail of the track gave a firm bearing to the jacks. No difficulty was encountered in lining the truss in this manner, it being merely necessary to jack the truss over until the

FIG. 1. LOOKING ALONG DAM NO. 5, SHOWING AT LEFT THE REINFORCING TRUSS

floor-beam hangers came into position. When the 216-ft. 6 in. truss left the blocking, it dropped approximately $\frac{1}{4}$ in. at the L_3-L_5 panel. The drop in the 156-ft. 6 in. span was still less noticeable. It was observed that at several panel points the lower chord was high after the

truss was completed, having no bearing on the camber blocks. It is assumed that this fault may be traced directly to the fact that although the various sections were fitted together at the shop prior to shipment, the trusses were not assembled entire and reamed to camber.

Arrangement of Screwjacks and Supports

The new trusses having been lined, they will be brought to their final position by means of screwjacks constructed and arranged after the manner described below. In order

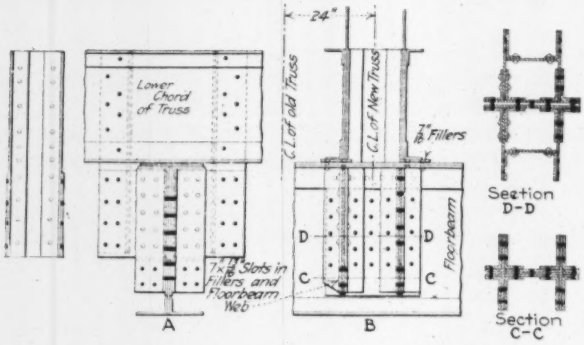


FIG. 2. CONNECTION BETWEEN POST AND FLOOR-BEAM

to understand fully the use of these jacks it is necessary to describe briefly the type of floor-beam hanger connecting the floor-beams to the trusses.

Fig. 2 shows the floor-beam prepared to take the truss; *A* shows the diaphragm attached to the truss, while *B* shows the new truss in position on the floor-beam. It will be noticed that the diaphragms below the truss are not punched to take the holes in the floor-beam hanger. These holes are drilled in the field after the truss has been swung to its final position.

The arrangement and construction of the jacks are shown in Fig. 3. As is shown in the sketch, two jacks were employed at every panel-point, one on each side of

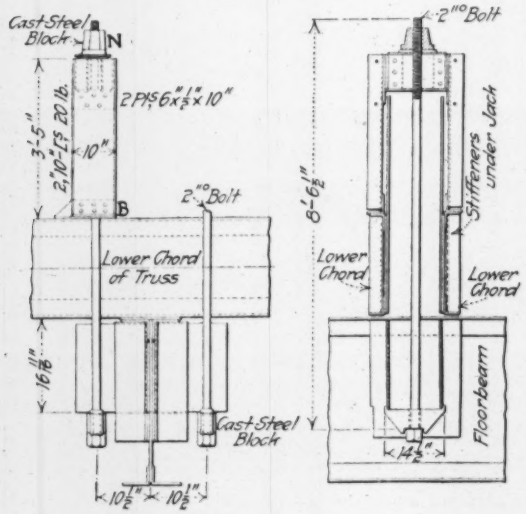


FIG. 3. DEVICE FOR JACKING UP FLOOR-BEAM

the floor-beam. The cast-steel blocks at the bottom of the jacks engaged the floor-beam hangers after the manner indicated, and, as may be observed, the bearing on the top of the lower chord at *B* brought the truss and floor-beam together when the cast steel nut *N* was turned down.

The two main uprights in the jack are 10-in. 20-lb. channels, back to back, with 6x4x½-in. lug angles, 1 ft. 2 in. long at the foot of each. These lugs are provided with three slotted holes each to permit bolting to the chord angles which have open holes for this purpose. The holes are slotted to allow a slight adjustment of the jack after it has been raised to a working position, and at the same time insure good holes for the bolts, while avoiding rivet heads in the floor-beams. The top of each channel is stiffened with one 6x½x10-in. plate, which also forms a shelf for the connecting lugs on two 8-in. 16¼-lb. channels, which separate the vertical channel posts. A finished cast-steel plate resting on the flanges of these 8-in. channels provides an accurate bearing for the cast-steel nut. The 2-in. bolt is threaded for 2 ft. 2 in. at the top with standard thread, which is more than sufficient to care for any variation in the sizes of chord sections over which these jacks will be operated on other structures.

At the time of writing, the jacks are in position on the 216-ft. 6 in. span, but it will be impossible to swing the truss until such time as the gates of the dam are lifted, since the bridge under the existing conditions is fully loaded, and the specifications dictate that this work shall be done under more favorable conditions.

The Whitehead & Kales Iron Works of Detroit, Mich., has the contract for the reinforcing work at Dam 5 and for six other dams of a similar type along the barge canal. The work is under the supervision of E. L. Andrews, field superintendent, and W. A. McKeough, foreman.

Motor Trucks for Heavy Structural Steel

By William Collins, Jr.*

It is common in New York City to see teams of from 4 to 20 horses hauling trucks loaded with huge steel girders and columns for building and elevated-railway construction. The use of motor trucks for this service is rare, but has been tried with success by George H. Pride, a subcontractor on the new Jerome Ave. elevated structure, an extension of the Lexington Ave. subway.

The greatest amount of steel to be hauled and stored in any one place was on River Ave., a narrow and unpaved section of the route. In wet weather this street was almost impassable to any vehicle, and the comparative ease with which the heavily loaded motor trucks traversed it was a revelation. The heaviest girders were 80 ft. long, weighing 32 tons, and several were as long as 107 ft., weighing 23 tons; the average was 50 ft. long and weighed 7 tons. The average length of haul was 2 mi., a large part of which was through unpaved streets.

The steel was delivered on lighters by the American Bridge Co. at a city dock, 155th St. and Harlem River. No steel was stored on the dock, the trucks being loaded by the lighter's derrick. The trucks are of 6½ tons' capacity, 38 hp., and have special flat bodies. The trailers, which are of special design, are substantially built, yet conform in a pleasing manner to the lines of the tractors. They have withstood a remarkable amount of abuse and rough handling. The reach poles which connect the truck

*Inspector for Public Service Commission for the First District, State of New York, New York City.

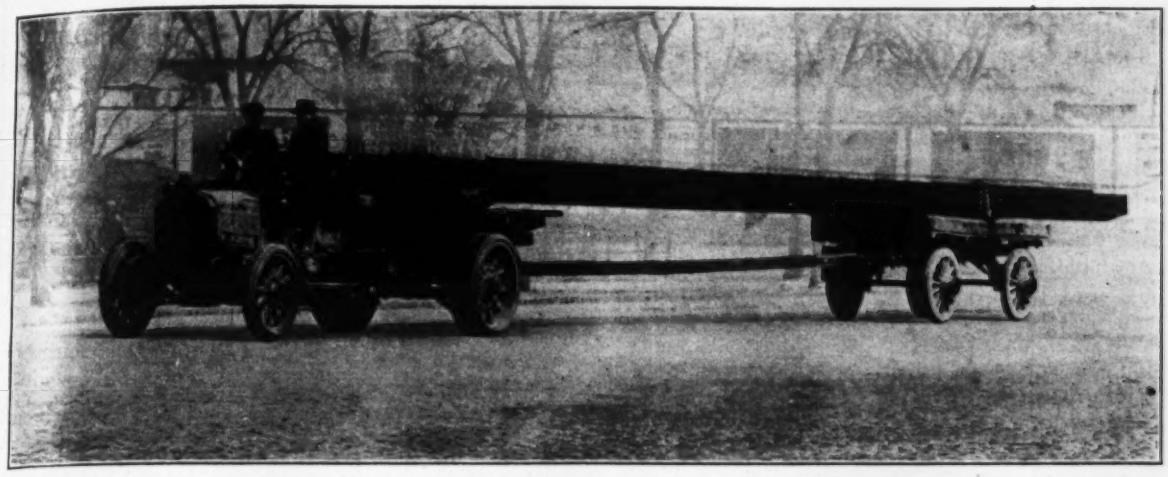


FIG. 1. MOTOR TRUCKS AND TRAILERS HAULING HEAVY GIRDERS FOR ELEVATED-RAILWAY CONSTRUCTION

and trailer can be detached quickly, so that they may be replaced by longer ones or shorter ones to fit the length of steel to be handled. They are pin-connected to the rear of the truck.

The girders were hauled as shown in the accompanying views, the front end resting on a 10x10-in. block which was free to slide on the truck. The rear end, resting on a rail fastened to the trailer, was lashed in place by a chain, the slack in which was taken up by a 12-in. turnbuckle with hooks on both ends, which held the girder firmly in position. The girders, when they reached their destination, were skidded from the truck on to rope mats, after which the mats were withdrawn and the girders placed in an upright position in storage piles on 4x4-in. blocks. The columns were hauled on two-wheeled underslung trailers.

Great care was required to bring the 107-ft. longitudinal girders through the narrow, traffic-crowded streets which they had to traverse to reach River Ave. These girders were placed on two trailers as shown in Fig. 2, and two trucks were used to bring them up some heavy grades. In spite of the fact that a sharp turn had to be made to get into River Ave., it was accomplished with comparatively little interruption to traffic on 161st St., where there is a crosstown trolley line with a headway during rush hours of less than two minutes. These long girders and the 32-ton girders were delivered at a time which allowed the contractor doing the steel erection to unload them with the erection derrick-car, which transferred them directly to the structure.

Motor-truck transportation was also used successfully and profitably on the White Plains Ave. extension of the Lenox Ave. subway and on the Brooklyn rapid-transit extension of the Fulton St. elevated line in Brooklyn, both of which are parts of the new dual rapid-transit system being built at the present time in New York City. On these particular jobs, however, the haul was long, the steel was delivered in large units, and there was no time lost in loading and unloading. These are the essential contributing factors to the contractor's success.

Bids made by teamsters for these jobs were from 25 to 35 per cent. greater than the price received by Mr.

FIG. 2. DOUBLE TRAILERS FOR HAULING LONG ELEVATED-RAILWAY GIRDERS, NEW YORK CITY

Pride. The general contractors for the Jerome Ave. and White Plains Ave. sections admitted having contemplated the hauling of the steel themselves, using teams for the large pieces and motor trucks for the smaller ones, but found it was cheaper to sublet the hauling. The subcontractor started hauling in the late winter and continued through the early spring in spite of the deep mud and heavy ruts in River Ave. These conditions alone would make it almost impossible for a teamster to realize a profit.

In building construction, however, where the steel units are small, the haul short and the dense traffic of the business streets cuts down the speed of vehicles, and where unloading is done by the erection derrick on the building, the trucks being made to wait until the derrick is idle, it would be impossible for motor trucks to compete. The reason is obvious. A motor truck which costs $20 a day to operate could not deliver sufficient tonnage under the prevailing rate of $1 per ton-mile for this class of teaming to pay its cost of operation.

The accompanying table gives the comparative costs per ton of motor truck and team hauling for the two adjoining contracts on Jerome Ave., where the conditions are almost identical.

COMPARATIVE OPERATING COSTS OF TEAMS AND MOTOR TRUCKS

Type	Average Length of Haul	No. of Trips	Tons per Trip	Cost* per Day	Cost per Ton
Motors, 6½-ton, 38-hp..	2 mi.	6	10	$20	$0.33
Teams 4-horse	2 mi.	4	5	10	.50

*Cost includes drivers, insurance, maintenance, etc.

It must be remembered that when it is necessary to haul a larger load than those referred to, such as long stringers and heavy cross-girders which average 12 tons, the teamsters find it necessary to double or triple the number of horses, using from 8 to 10 horses for the average cross-girder; and in case of a 30-ton girder, from 15 to 20 horses are required. This of course inflates the cost per ton beyond any comparison. The motor trucks, on the other hand, never required extra assistance for girders under 20 tons, one truck doing the work of 20 horses. This kept the motor trucks' cost per ton almost uniform.

To Mr. Pride belongs the credit of having demonstrated that heavy pieces of structural steel could be hauled cheaper, faster and with less interference to traffic by motor truck and trailer than by the time-honored methods. The employment of the motor truck and trailer in all fields of hauling is daily augmenting, but this marks a great step.

Wagon Loaders for Broken Stone

On road and other construction where bulk material such as stone, sand, gravel or coal has to be hauled from a railway siding to the work, special means are desirable for handling the material between the railway cars and the wagons or motor trucks. If the material is shoveled directly, the shovelers have to wait until vehicles are ready, they cannot see if they are delivering it properly, and the vehicles stand idle while being loaded. This involves much loss of time. With horse or mule haulage a certain amount of rest is required for the animals (though not as much time as it takes to load the wagon); but with tractor haulage, motor trucks or industrial-railway haulage this idle time is a dead loss.

Two methods of handling material in such cases are noted below—one where the material is delivered in railway dump cars or bottom-discharge cars and the other where it is delivered in gondola cars and must be unloaded by hand.

The first device, shown in Fig. 2, consists of an inclined bucket elevator and a storage bin, the elevator being driven by a small gasoline engine. The apparatus is readily portable by rail or road. It is erected at the siding, and a pit is excavated for the lower end of the bucket incline. This pit is lined with wood. An inclined chute is cut from the pit to the track, and in this is fitted a steel trough. A gate controls the flow of material to the bucket, which is of ¾-yd. capacity. At the top of the incline the material is dumped into the bin, which may be of from 15 to 50 tons' capacity, and from this it is discharged into the wagons, trucks or dump cars through gates and spouts. The elevator can handle from 250 to 500 tons of material daily, and it is stated that the transfer from car to wagon will cost not more than 2c. per yard. The apparatus is built by the Galion Iron Works & Manufacturing Co., of Galion, Ohio.

The second method of handling, where hand shoveling is necessary, is to place beside the car steel bins or hoppers, which are loaded by the men in the car and dumped when a wagon or truck is placed beside them. Thus the shovelers can work more steadily, they spill and waste less material, and the wagons are loaded very quickly. The device shown in Fig. 1 has a steel hopper carried by a frame which is hung directly on the side of the car.

FIG. 1. PORTABLE WAGON LOADER ATTACHED TO RAILWAY CARS

The hopper is so balanced that when loaded it will dump automatically when the latch is released. The hoppers and frames are easily handled. This device is built by the Barney Supply Co., of Rochester, N. Y.

A somewhat similar loader built by the Lee Loader Co., of Chicago, has the hopper mounted on light steel frames placed beside the car, instead of being attached to it, as in the former case. Thus the loader is quite independent of the car. The hopper is not pivoted, but

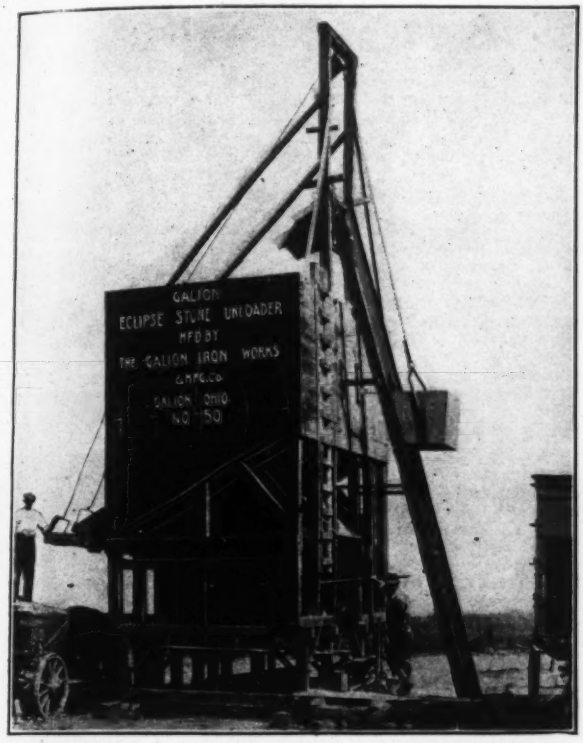


FIG. 2. PORTABLE LOADER AND BIN FOR TRANSFERRING MATERIAL FROM RAILWAY CARS TO WAGONS

has a round bottom upon which it rolls across the frame in dumping. It thus discharges its load clear of the supports, and rolls back to the side of the car. It is stated that in some cases these loaders have enabled the team or wagon equipment to be reduced considerably owing to the great reduction in lost time due to loading. The hoppers are made in sizes of from ¾-yd. to 5-yd. capacity, the larger ones being for loading motor trucks. These loaders can be carried from place to place in a wagon or truck.

Washing Paint Charged to Infected Oil

Deterioration of linseed-oil paints may often be due to fungus introduced with unclarified oil. Studies of paint which showed "washing" led Henry A. Gardner, of Washington, D. C., to conclude that microörganisms are probably responsible; that these originate in the oil and feed on it; and that the original sedimentary impurities or "foots" in the linseed oil are the seat of the trouble. The observations, together with other studies of fungus growth on paint, are reported in the June issue of the *Journal* of the Franklin Institute under the title "Some Curious Painting Phenomena."

Washing is found most commonly on concave surfaces, as the flutes of porch columns, presumably because moisture is held here longer. It is generally indicated by the appearance of a white deposit at the base of the column and by the paint assuming a soaplike condition. It occurs rather rarely, but in at least one instance it seems to have been almost epidemic in a community.

Study of the paint materials used in several instances of washing showed that the linseed oil contained considerable moisture and a large percentage of mucilaginous or albuminous matter commonly called "foots," indicating poorly clarified oil. The "foots" were found to grow a peculiar pink-colored mold on agar. It was indentified as a species of *Fusarium*. This mold was found capable of injuring the oil, setting free fatty acids and glycerine. The action of these substances in conjunction with the moisture of the air keeps the paint soft and allows of the washing down of saponified portions of the paint film.

Both lead and combined lead-zinc paints are affected by washing.

Mr. Gardner's belief is that the infection is removed from the defective oil by proper clarification.

Canvas Air Duct in Tunneling

The innovation introduced by Thos. Connor & Sons in their tunneling work on the Mill Creek sewer in St. Louis—canvas tubing for air conduit—claims attention for application to all future tunneling as well as other construction work where low-pressure air has to be piped. The contractors report not only a gain in first cost, but—what is more important—a saving of delay and trouble in handling the air pipe at the heading just before and after shooting.

The job was started with galvanized-iron ducts in the shaft and the headings. On account of the time lost after shooting in reëxtending the air pipe to the heading, the contractor took up with the Bemis Bros. Bag Co. the question of supplying some form of flexible conduit. Experiments led to producing a duct or tube of heavy rubberized fabric, in sizes up to 24-in. diameter, which was practically air-tight and water-tight, and was much cheaper than galvanized-iron pipe. Made up in 100-ft. lengths, and joined by a special coupling—an inside metal sleeve grooved at both ends, with clamping rings fastened over the ends—it can be rolled up or reëxtended very rapidly.

At the shaft the contractor has a 15x24-in. Jeffrey blower, delivering 10,000 cu.ft. per min. under 2-in. water head. A 24-in. tube of the rubberized fabric—called "Flexoid"—carries the air down the shaft, and from here a 16-in. Flexoid tube leads it to the headings, about 1600 ft. each way from the shaft.

D. H. Blanks, engineer for Thos. Connor & Sons, estimates that just before shooting, the blower having been shut down, one man can roll up the duct for 200 ft. or more in one or two minutes, and that it can be replaced in even less time after shooting. This is a great saving in labor over the corresponding handling of metal duct.

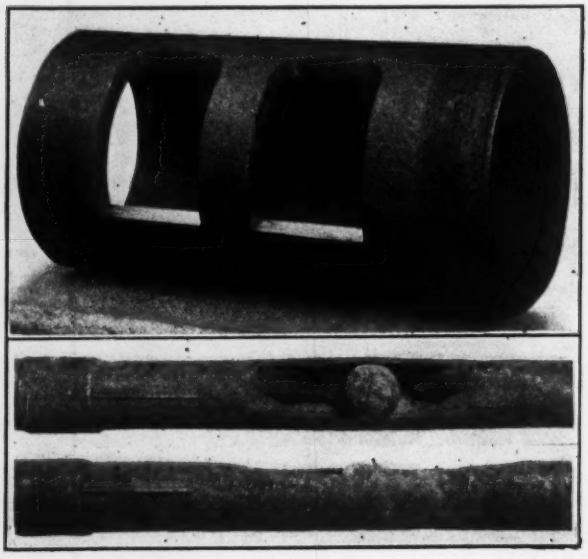
The Flexoid duct has been in use for 5 mo., and a portion of it has been replaced. Mr. Blanks considers that its life would be much greater in a perfectly dry tunnel,

the loss to date having been largely due to weakening from damp rot. As matters stand, however, he figures that by the time the excavation is finished, about 8 mo. in all, the whole installation will have been replaced once. This still represents a great saving in first cost, as the Flexoid costs only about 20 per cent. as much as sheet-metal piping.

The makers of the canvas duct believe it can also be used as temporary water conduit in many instances. Its chief field, however, is ventilating air service. Because it is so simple to handle and does not obstruct other work, it may lead to putting in ventilation in shaft or deep trench work, now done without ventilation.

NOTES

Well-Casing Freaks—The accompanying views show some mistreated pieces of well-casing secured by the National Tube Co., makers of the casings. One specimen shows three telescoped sections. These were the bottom lengths of a 1640-ft. string of 8¼-in. tube which dropped 200 ft. to a



TWO WELL-CASING FREAKS

limestone bottom. Two lengths were completely telescoped and a part of the third; no other injury was evident. The second view shows a casing with an embedded stone which worked in while the tube was being sunk and without causing the pipe to collapse.

Old Granite Block Not a Satisfactory Foundation for Asphalt—About 15 yr. ago the plan of rebuilding the pavements of many of the streets of New York City with a sheet-asphalt surface, using as a foundation the old paving stones, was inaugurated. This has proved a costly blunder for the city, for the unevenness of the foundation has made it very expensive to keep the top surface in good condition. The wear and tear caused by modern traffic is so great that the foundation is just as important as the top surface, and experience has proved that it should be brought to a smooth surface and exactly parallel with the top of the wearing course, in order to accomplish the best results. If there are any depressions in the foundation, in time the traffic will roll out the asphalt so as to follow these indentations. It is both difficult and expensive to keep the surface of the streets in a satisfactory condition if the foundation is uneven, and it therefore becomes necessary after a number of years to remove the top, or wearing, surface, and bring the foundation to a proper surface by filling in the depressions with concrete. In parts of New York such as lower Manhattan or along the main lines of travel and where building operations are active this should be done about every 10 or 12 yr. In other parts, where the conditions do not change so quickly, the foundations may remain in good condi[tion] 15, 20 or even more years. There are streets in New York [which] have not been repaved in over 20 yr., and there is a [sheet]-asphalt pavement in use in the Murray Hill district on [Fifth] Park Ave. laid in 1889, and still serviceable.—From the [Report] Annual Report of the President of Manhattan Borough, [New] York City.

Baltimore Sewer-Cleaning Scow—The lower end of the large outfall sewer of Baltimore, Md., is cleaned by means of a scow to which is attached an adjustable dam. The sewer is 12½ ft. wide and the scow nearly as wide. It is built of [2]-in. plank on a framework of 6x8-in. stuff. The dam is hinged to the rear of the scow and in cross-section is of the same shape as the lower part of the sewer, but 1 ft. less in diameter. When the sewer is to be cleaned the scow is pulled upstream from the disposal works in the following manner: A man in a small scow or boat paddles up to the first manhole with a rope that has been attached to the large scow and fastens the rope to one of the iron steps. The men in the large scow pull it up to the manhole and secure it there. The process is repeated from manhole to manhole. While the scow is being towed upstream the dam folds over the end of the scow and floats. When ready to start cleaning the dam is placed in a vertical position and braced with guy ropes that can be quickly loosened in case of emergency. The flow of water beneath the boat and dam scours the deposit from the sewer bottom. The small scow follows the large one closely on its way downstream and helps the three men in the large scow keep the latter to rights. The scow is pulled upstream about two miles from the disposal works, or as far as the backwater caused by the tanks extends. Above this point there is no trouble from deposits and such sediment as is found is hard and gritty, about 4 in. deep, and would not be loosened by the scow and dam. Calvin W. Hendrick is Chief Engineer of the Baltimore Sewerage Commission and G. J. Requardt is Acting Division Engineer at the sewage disposal works.

Crowning of Levee Tops seems to be a necessary provision when the river side of the levee is paved, according to recent experience with the levees near Kansas City during floods. Where the levee top was level and slightly below the top edge of the paving or revetment, heavy rains cut under the top edge of the paving and washed out large holes in the levee both on top and down the under side of the paving. Probably if the levee had been crowned above the paving slab such action would not have taken place. It has been shown by cost data kept on this work that it is cheaper to crown the levee and keep it crowned by constant maintenance than it is to fill up the holes discovered in occasional inspections.

An Unusual Drainage Problem—A very unusual situation was encountered by engineers constructing a concrete-lined irrigation canal through a section of land in Riverside County, California. This canal was for all-the-year-round use and carried about the same amount of water at all times. During its construction it was found that at various places it was crossed by storm-water drains, which during and immediately

CONCRETE AQUEDUCTS FOR CARRYING STORM WATER OVER IRRIGATION CANAL

after heavy rains carried large quantities of water. To prevent this storm water from entering the main canal and possibly causing damage, it was decided to carry the wash waters over the canal by the use of small concrete aqueducts or troughs. At various points these aqueducts were constructed and found perfectly satisfactory. During the rains of the past winter neither the aqueducts nor the canal was damaged.—Albert Marple, Tropico, Calif.

Editorials

What Are the "Mechanic Arts"?

The engineering profession in the United States owes a great debt to the Morrill land-grant law, enacted in 1862, which gave a munificent endowment in public land to at least one college in each state, "where the leading object shall be without excluding other scientific and classical studies and including military tactics to teach such branches of learning as are related to agriculture and the mechanic arts."

There has been much discussion as to the true definition of the term "mechanic arts" as used in the Morrill law. A committee of the Association of Land Grant Colleges, of which Prof. A. Marston, of Ames, Iowa, is chairman, has recently rendered a report upon this matter. This committee holds that instruction in the "mechanic arts" properly includes professional engineering education, trade-school and short-course instruction, and experimental investigations. The term "mechanic arts" is not derived from the use of the word mechanic to designate artisans, but refers to the science of mechanics. A correct and concise definition of "mechanic arts," therefore, is the arts which are characterized by the use of the science of mechanics.

The committee puts on record in its report that Senator Morrill, of Vermont, the author of the Morrill act, stated in a letter written nearly 30 years after the law was enacted that the use of the Federal endowment for the development of engineering education was in accordance with his original purpose.

Developing Naval Inventions by a Government Bureau

By inviting Thomas A. Edison to head a board for examining inventions which may be made useful to the navy, Secretary Daniels has called general public attention to one weak spot in our naval organization. Good as our navy undoubtedly is in many respects, it is after all only a copy of the best that can be found in foreign practice. With a few notable exceptions, the United States Navy contains nothing of importance that has been originated in this country.

There are those who defend this policy and urge that it is good business to "let the other fellow spend his money on experiments and then copy what he does." Private concerns which pursue this policy, however, seldom hold a leading position in their industry; and were it generally known by the public that our navy was merely an imitation of foreign naval practice there would be loud protest.

Our naval officers are not to blame that our navy follows, instead of leading. The reason why the United States waits for naval inventions—even those of American origin—to be developed abroad before taking them up here is found in the method by which Congress appropriates funds for Government work. The naval appropriation bill provides specific sums for building such and such vessels and performing such and such work; but nothing, or at best a trifling sum, is provided for the development of inventions useful to the navy.

The theory has been of course that inventors and manufacturers will develop their devices to the point of practical success and then offer them to the department. Rarely does this happen, and then it is usually in connection with devices which are worth development for other than naval uses. In the great majority of cases, however, those who offer new inventions to the Government will not undertake the expense and risk involved in adapting their devices to the especial needs of the navy. They have, in fact, little inducement to do so. The Government policy with regard to new devices, even of established merit, is to purchase them at ordinary manufacturer's profit. The sanguine inventor or manufacturer who spends his own money to develop a device for naval use is only too likely to receive no return for his outlay other than the gratification of his patriotic impulses. If, then, the Government will not furnish the means for improving its great fighting machines, there is little reason to expect that such improvement will be undertaken.

Secretary Daniels has now injected himself into this situation with the proposition that the Government ought to do something to promote the development of inventions useful to the navy. If he had merely embodied this recommendation in a message to Congress, it probably would have been wholly ignored. As it is, by the spectacular advertising scheme of securing Mr. Edison to head the proposed board he has brought it to public attention and something tangible may grow out of it.

Of course Mr. Edison and Mr. Ford and the other prominent and successful inventors and manufacturers who have been named in the newspapers will not do the actual work of the proposed board. Very likely in the ultimate organization they may not be even members, but men who know the navy and its needs and how to carry on the detail work of sifting and developing inventions would probably take their place.

It is of interest to note that a similar movement has assumed form in Great Britain, where a Naval Inventions Board has just been created by the government, made up of such noted men as Sir William Crookes, Sir Oliver Lodge, Sir Charles Parsons, Dr. Percy F. Frankland, G. G. Stoney, George F. Beilby and others.

In both Great Britain and the United States one of the great lessons of this world war is the importance to a nation of fostering the development of new inventions and new industries, instead of relying upon importations from other countries where such advances in industry do receive encouragement.

The idea is still prevalent that the United States leads other nations in mechanical progress. Fourth-of-July orators brag of Yankee ingenuity, and numerous amateur statesmen are confident that should our nation ever be so unfortunate as to find itself again involved in warfare, our inventors would promptly devise apparatus certain to insure the enemy's defeat.

Those who are familiar with mechanical progress in Europe, however, have no such illusions. In certain fields the manufacturers of the United States have indeed remained in the lead; but in most industries it is unfortunately true that America has lagged behind other industrial nations in the development of new processes and new machinery during the past twenty-five years. Rapid changes have certainly occurred in every field of American industry; but a careful inquiry will show that a large proportion of the new devices have been developed abroad and their merits have been established there before they were introduced in this country.

There is no lack, it is true, of American ingenuity. By this we refer not to the country cross-roads inventor of the type who flourished three-quarters of a century ago but to the skilled and educated engineer and mechanic who knows the problems to be solved and the methods necessary for their solution. Unfortunately inventors of this class very often find their efforts fruitless, not because of lack of merit in their work but because manufacturers in the United States, in many fields, at least, will not take up any radically new invention until they are absolutely obliged to do so by competitive conditions.

The events of the past year have revealed to the world the extent to which Germany has made use of the inventive ability of her people. The other industrial nations have never before realized the degree to which they have become absolutely dependent on German production in many important fields, simply because German manufacturers, with the backing of the German Government, have had the energy and enterprise to undertake the development of new inventions to an extent unknown in any other nation. Certainly this lesson ought not to be lost upon the American people.

Secretary Daniels' scheme for a Bureau of Naval Inventions will at least serve the important purpose of directing general public attention toward this great need of our Navy Department. Congress does not hesitate to spend $16,000,000 to add another dreadnought to the navy. Why then should it hesitate to appropriate $1,000,000 or $2,000,000 or $5,000,000 for the Navy Department to spend in developing new inventions which promise to be of direct usefulness to the navy? Many of these inventions would be of value also in the merchant marine service, where also American prestige is sadly lacking.

Division of Earnings between Capital and Labor

The question how earnings are divided between capital and labor is one of wide popular interest. Many people believe that capital gets the lion's share. Back of most movements for strikes and other attempts to force up the rate of wages is the prevalent idea that the employer makes such profits that he could if he desired pay all who work for him some such extravagant rate of wages as that so widely advertised with reference to the Ford motor plant.

Nor are such views held by ignorant laboring men alone. It has been publicly claimed that of the annual product of industry, only one-fifth goes to labor, and capital takes the other four-fifths. No less a man than the Vice-President of the United States, in a commencement day address a year ago, declared that whereas in 1850 capital took three-fourths of the products of industry, at the present time it took four-fifths and left the laborer only one-fifth.

A committee of the National Civic Federation has just rendered a notably useful service by making a thorough investigation to determine the truth regarding this matter. The committee has taken official statistics collected by the Census Bureau, the Interstate Commerce Commission, and some of the large corporations, until it has actual figures covering industries employing more than 10,000,000 people.

From these statistics the committee finds that of the net earnings of industry in general about two-thirds is paid out in wages and salaries and one-third goes to pay interest, dividends and depreciation. Thus, instead of the laborer receiving only one-fourth as much as the capitalist, he receives twice as much. In fact, labor receives more than twice as much as capital, for depreciation has to be deducted from earnings before interest or dividends can be paid.

The fallacious idea that labor receives only one-fourth as much as capital appears to have grown out of a misunderstanding of the 1900 census statistics of manufactures. These statistics gave the value of manufactured product per employee per annum in the manufacturing industries of the United States as $2420 and the average wages per employee as $437. The cost of materials used in manufacturing, however, were $1395, per employee, and this as well as other expenses of carrying on the business must be deducted before any payments can be made to capital.

Taking the figures of the 1910 census, it appears that the average earnings per employee in the manufacturing industries of the United States, after paying for the materials used and for taxes, advertising, insurance and all other expenses, were $889. Of this amount $590 was paid out in wages and salaries and $299 was left for capital. Before paying the interest or dividends, however, the expense of depreciation or of repairs to prevent depreciation had to be met. Allowing 5 per cent. as a fair depreciation rate, there was left $175 as the net earnings of capital per employee; or labor got about $10 for every $3 received by capital.

An interesting check on these figures may be obtained by taking the statistics for wage payments and capital payments on the steam railways of the United States, collected by the Interstate Commerce Commission. In 1914 the total amount paid out in wages to steam railway employees in the United States was $1,245,000,000. In the same year about $804,000,000 was paid out in interest and dividends on steam railway bonds and stocks, so that for every $3.50 paid to labor, capital received about $2. This larger relative return to capital in the case of the railway industry than in manufacturing is explained by the fact that the amount of capital invested in railways per employee is very much larger in railway transportation than in manufacturing industries. The capital invested in railways per employee is about $10,000; the capital invested per employee in manufacturing industry is about $2500.

It is possible roughly to check these figures in another way. The United States Census Bureau has just issued a report on wealth, debt and taxation which contains an estimate of the total wealth of the United States. This total is, in round figures, $188,000,000,000. It also shows the total amount collected by the states, counties, cities,

etc., by taxes on property amounting in 1913 to $1,350,000,000. Adding to this the taxes on property which are collected by the Federal Government, we have, in round figures, about $1,500,000,000 as the taxes paid annually by the property owners of the United States out of their income.

If we assume that the average annual income on all wealth is 4 per cent. (which is probably a high estimate), the total annual income on all the wealth of the United States is about $7,500,000,000, and deducting the taxes, the net income is $6,000,000,000.

To obtain, now, the earnings of labor of all classes, suppose we assume that one-fifth of the population of 100,000,000, or 20,000,000 persons, are engaged in industry of some sort or other and that their average earnings are $600 per year. (This compares closely with the $590 per employee in manufacturing industries determined by the Civic Federation committee.) Then the average earnings of these 20,000,000 workers averaging $600 apiece would be $12,000,000,000, or twice as much as the annual income from all the wealth of the United States. This checks closely with the results obtained by the Civic Federation committee.

In considering the vast wealth of this country it is well to remember that a very large proportion of it is owned by people of moderate means. The farms of the United States with their equipment alone are valued at about $41,000,000,000. The billions of dollars represented by savings-bank and life-insurance investments is a form of wealth which consists of the accumulated savings of millions of people.

Again, as much as 8 per cent. of all the real-estate wealth of the United States, or over $12,000,000,000, is owned by the public, in the form of school buildings, hospitals, parks, churches, asylums, and public buildings of all classes. Of that part of the earnings of industry which is paid for the use of capital, therefore, only a small part goes to increase the accumulations of the wealthy.

Another very important fact developed by the Civic Federation committee is that in the division of earnings between capital and labor, labor's share is increasing at the expense of capital's. In 60 years the average annual wages per employee in the manufacturing industries of the United States has increased from $247 to $518, and during the same time the average rate of interest has been reduced by more than one-fourth.

It is sometimes claimed that the tendency of labor-saving machinery is to increase the amount of capital required and reduce the wages of employees; but the official statistics prove that any tendency of this sort has been more than offset by other forces, which have increased wages and lowered the return on capital.

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Be Sure to Prepay Full Postage on Foreign Business Letters

The warning has been often published that postage should be fully prepaid on letters mailed to foreign countries, and that if this is not done the receiver of the letter is obliged to pay not merely the amount by which the postage is deficient but double this amount. Notwithstanding such warnings, cases of underpaid postage on American letters to foreign countries continually occur. A correspondent of *Engineering News* in Calcutta, India, writes as follows:

> An an American who has been doing business in India for many years, I know the irritation that is caused when business firms here receive letters with deficient postage. The amount of the payment is small, but the irritation resulting is great. American firms are the greatest offenders in this respect, and it has to my knowledge been the cause of the loss of a great deal of business. It is the rule and not the exception that business firms will remember this matter, which to an American may seem so trifling, to the detriment of further business relations.

At this particular time, when many American business firms are making a special effort to increase the amount of their foreign trade, it seems well worth while again to call attention to this matter and also to suggest that on bulky foreign letters, in order to be on the safe side, it is best to attach an additional stamp to what the scales may indicate as necessary. In the damp atmosphere of the ocean voyage the paper of the letter absorbs moisture and increases in weight; and a bulky letter or document which may have passed the scales when it was mailed in the United States may be overweight when it finally reaches its destination.

⁂

Putting Municipal and Private Utilities on a Par

New evidence of the spreading tendency to subject all municipally owned utilities, like electricity and gas works, street railways, etc., to the same standards of operation and finance that are applied to public-service companies under private ownership is seen in a recent decision of the California Railroad Commission. The City and County of San Francisco applied for permission to carry the tracks of the Municipal Ry. on Potrero Ave. at grade across two main tracks and a siding of the Southern Pacific Co. It further asked that the expense of maintaining the main-line crossing be ordered divided between the municipality and the railroad and that the spur crossing be maintained by the railroad. Special privilege was claimed by virtue of being a municipal corporation.

Investigation showed that the railroad had a franchise from the city permitting it to cross Potrero Ave. with its two main tracks, but that the siding existed only on sufferance. Permission was granted the city to make the crossing, but the entire expense of construction and maintenance was imposed on the Municipal Ry., under the usual rule of imposing the burden of a grade crossing on the junior company. Municipal privilege was specifically denied, and certain similar cases in Los Angeles were cited as precedent.

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Worse Than the Edison Fire!

Without naming any names, it is a pretty fair bet that the hearts of certain folks must have been glad within them when they read in a recent issue of a Portland, Ore., newspaper the following glaring headline:

CONCRETE BUILDINGS
BURNED TO ASHES

How great must have been their disappointment when a farther reading showed that the item described the destruction of the frame buildings comprising about half of the business section of the town of Concrete, Wash., which apparently was christened without regard to the type of buildings it contains.

Letters to the Editor

What Is "Pure Iron"?

Sir—On p. 78 of *Engineering News* of July 8, 1915, you have an extract from the *Reclamation Record* of May showing the results of exposure tests upon two grades of "pure iron" and two of "common steel." Feeling that the information therein given may mislead certain people, I deem it my duty to write calling your attention to the definition of pure iron adopted by Committee A-5 of the American Society for Testing Materials, perhaps the most authoritative body in this connection.[1] At a meeting held in Atlantic City, June 23, 1915, the following chemical composition was adopted for the class of metal known as "pure iron":

Carbon	under 0.02%	Phosphorus	under 0.01%
Manganese	under 0.03%	Copper	under 0.03%
Sulphur	under 0.03%		

A comparison of this analysis with the one given in your magazine shows that "pure iron" Nos. 1 and 2 could not come under the specification for "pure iron" adopted by Committee A-5. I feel that you should make note of this difference.

MONT SCHUYLER,
Engineer in Charge,
Municipal Testing Laboratory.

St. Louis, Mo., July 14, 1915.

Some Questions About the Austin, Tex., Dam

Sir—In connection with the very interesting article by Frank S. Taylor in *Engineering News*, June 3, 1915, on the rebuilding of the dam at Austin, Tex., several matters seem to call for comment.

It is stated that rerolled twisted steel was used and that stresses of 16,500 lb. per sq.in. were allowed. As rerolled steel for reinforcement purposes is generally regarded as entirely unreliable, it would be interesting to know if each shipment of steel for the Austin Dam was tested and what the results were, particularly with regard to uniformity of product.

According to Fig. 4, the roof of the sluiceways is reinforced horizontally near the bottom only. As, under certain conditions, these conduits would be subjected to considerable internal pressure, there would be tension in the roof near the top, where there is apparently no steel to resist it.

It is assumed in the article that grouting of the foundation and cutoff can be relied upon to secure a reconstructed foundation. The writer believes that grouting should merely be considered as a measure "to make assurance doubly sure."

Even where the work of grouting is as carefully done as it evidently was at Austin, there is no certainty that the grout actually does what is expected of it. When grout rises out of a hole adjacent to one into which the grout is being forced it is generally taken as "proving that the underground seams between these two holes are thoroughly filled with grout." It is conceivable, however, that this is not always the case. Assume that between these holes there are two seams, one a large seam, offering but little resistance to the flow of the grout through it, and the other a narrow seam, in spots tightly filled with sand. Under such conditions the grout may clog before it has gone very far in the narrow seam. All the grout flows through the other seam and rises in the adjacent hole, the narrow seam remaining practically open between the two holes. Again, mud seams which at the time are tight may later wash out.

It is more than probable that these conditions occur frequently in actual practice, and the writer ventures the opinion that if holes were drilled near the upstream toe and at intermediate points, and pipes cemented in them, observations taken after the dam is in service would show a considerable head in these pipes. In the article no mention is made of the depth of the grout holes or of the cutoff wall.

It is stated that "it was decided to build a hollow dam of reinforced concrete of such form that there could be no uplifting force from any leakage of water under it." The omission of a reinforced-concrete floor in the hollow dam does not secure this much-to-be-desired condition, as the uplifting force may act on the rock stratum itself. This would certainly be the case to a greater or less extent unless the rock is so broken up that the water flows freely from it. But in the latter case the velocity head of the water issuing from the broken up rock might conceivably be sufficient to move loose rock and thus endanger the footings of the buttress walls.

It is stated that for the foundations of the buttress walls, the rock wherever it was considered satisfactory was found to be firm for a depth of 4 ft. If we assume a net head of 65 ft. developing full hydrostatic pressure on the under side of this firm layer of rock 4 ft. thick, we have, in effect, a slab or beam of rock of 20 ft. span and 4 ft. thickness against the under side of which is exerted an upward hydrostatic pressure of 28 lb. per sq.in. This would mean a tension in the upper fibers of this layer acting as a beam of over 500 lb. per sq.in., which of course is more than the rock would stand.

Accordingly, it is clear that the engineers responsible for this structure must have been very firm in their conviction that the condition outlined in the foregoing was impossible of even partial realization. Extreme caution might, perhaps, have dictated the inclusion of a concrete floor under the dam, reinforced against a portion of this upward pressure and copiously provided with weep-holes, together with holes bored in the underlying strata concentric with the weep-holes, thus relieving the upward pressure and reducing it to the minimum.

The writer does not believe that any dam was ever built "of such form that there could be no uplifting force." Although there are of course cases in which the

[1] The subject of Committee A-5 is "Corrosion of Iron and Steel." "Engineering News" considers the fact worth note that this committee has nothing to do with specifying iron and steel or defining their qualities.—Editor.

desi[illegible] might be justified in failing to take it into consideration. In the Austin Dam there is no base, which is probably the author's justification for the statement previously alluded to; but the underlying rock acts as the base, and against this rock upward pressure will be exerted—to what extent only those familiar with the details of the work and its foundation are competent to say.

JOEL D. JUSTIN.

Harrisburg, Penn., June 10, 1915.

[This letter was submitted to Mr. Taylor, the author of the article on the Austin Dam and the resident engineer on that recently completed structure. He has replied as follows.—Editor.]

Sir—With regard to the twisted steel, I should have written "square rolled twisted steel" instead of "rerolled," which latter was an error. We did use "ingot" steel square twisted bars, all tested by competent engineers before being used, according to the requirement of our standard specifications.

The construction of the foundation by the grouting process, as described, was mentioned only generally. Every part of the cutoff wall foundation was made impermeable to a depth of about 12 ft. below the bottom of the trenches for that wall, and test holes were always drilled between the grouted holes for the purpose of proving to ourselves that the space between the two holes grouted had been made impermeable. If the indications were such as to still leave a permeable condition, the process was continued until an impermeable foundation was achieved for the cutoff wall.

Mr. Justin computes that a slab of rock 20 ft. long, having a thickness of 4 ft. or more, as indicated by our tests, would have a tension in the upper fibers of over 500 lb. per sq.in. This calculation is based upon the assumption that the beam of rock would be just 4 ft. and that it would be a simple beam and 20 ft. long. The wall foundations had spread footings that averaged 4 ft. This reduced the span to 16 ft., and if the conditions of beam existed, we would have a continuous instead of a simple beam. The actual conditions encountered, however, indicated rock considerably more than 4 ft. in thickness, punctured with seams and test holes, so that no part of the foundation could be conceived to have an upward thrust equal to more than the resistance of that force which would be required to move accumulated mud from the cracks, provided that water permeated under the grouted portion of the cutoff wall to create such pressure.

The report of the grouting of the foundation of the Austin dam is, in itself, a considerable volume, more than 300 holes having been drilled, the log of each hole as it was drilled carefully observed, and the treatment of each hole separately described and recorded.

It would be impossible to cover technically all the details of construction in the scope of an article like that written for *Engineering News*, one of the unintentional omissions from that article being a paragraph describing the conditions under which cement was used in our aggregate. The cement was furnished by the Texas Portland Cement Co., tested separately at the mill for composition and soundness, handled under specific regulations in proper warehouse, and mixed under the constant supervision of assistant engineers.

FRANK S. TAYLOR.

Austin, Tex., June 26, 1915..

Mexican Railway History

Sir—On Dec. 2, 1857, Senor Don Antonio Escandon, a Mexican capitalist, in consultation with Gen. Manuel Robles, who represented the Mexican Government at Washington, engaged the services of Andrew Talcott, a former captain in the Corps of Engineers, U. S. A., to make surveys for a railroad from Vera Cruz to the city of Mexico.

Immediately after his appointment Captain Talcott organized a corps of engineers in the city of New York, which sailed from New Orleans Jan. 1, 1858, and landed in Vera Cruz Jan. 4 following. The members of this corps were:

Capt. Andrew Talcott, Chief Engineer; Andrew B. Gray, Quartermaster and Commissary; J. S. Stoddart, Assistant Engineer; Richard Page, Assistant Engineer; L. Van Wyck, Assistant Engineer.

First Brigade—M. E. Lyons, Chief Engineer; E. M. Richards, R. F. Stack, T. W. Sargeant, W. W. Dechert, A. C. Hall, E. McLenegan, J. Radnich, James J. Arnold, George E. Clymer.

Second Brigade—R. B. Gorsuch, Chief Engineer; D. S. Crosby, W. R. Eastman, A. Van Burcke, James Emmet, T. A. Emmet, H. G. Webber, L. B. Ward, O. W. Bownton, Alfred Delano, D. M. Gorsuch.

Exploring Party—Sidney Coolidge, Chief; T. M. R. Talcott, Charles Miller, C. A. Wolf, George R. Talcott.

Of the above T. M. R. Talcott, of Richmond, Va., and W. R. Eastman, of Albany, N. Y., I know to be still living.

Maj. Sidney Coolidge, 16th Regiment, U. S. A., was killed at Chickamauga during the Civil War.

I am very much interested to obtain information relative this survey and would like to hear from any who can give information.

EMILE LOW.

745 Lafayette Ave., Buffalo, N. Y., July 13, 1915.

Authorities Against Rivet-Tension

Sir—In response to Ernest McCullough's call for views of your readers on the use of rivets in direct tension (issue of June 10, 1915, p. 1139), permit me to call his attention to an article in the *Zeitschrift des Vereins Deutscher Ingenieure*, Nov. 23, 1912 (Vol. 56, No. 47, p. 1890), on "The Effects of Stresses Produced in Materials by Riveting."

This article describes a set of experiments which show that the tensile stresses in ordinary rivets parallel to the shank, after they have cooled subsequent to being driven by a hydraulic riveting machine, are 2200 kg. per sq.cm., or about 31,000 lb. per sq.in. A bolt heated to a dark cherry red, with the nut tightened just to bear on the metal, without initial pressure, was stressed to about 42,000 lb. per sq.in. on cooling.

The lower stress in the rivets is explained principally by the fact that the process of riveting heats the surrounding material and allows it to shrink together with the rivet on cooling. The large nut on the bolt is also more rigid than a rivet head, and bears on a larger area of metal, thus producing a smaller linear compression in the plates and a correspondingly greater elongation of the bolt shank, with the resulting higher stresses.

A simple computation of the amount of shrinkage on cooling from the riveting temperature, as well as experience with broken rivets, shows that most rivets must be stressed beyond the elastic limit, and often up to the

point of failure, especially on the outside of the shank, right under the head.

The foregoing seems sufficient to condemn the use of rivets in direct tension. In fact, the *shearing* strength of the undriven rivet, which is a function of the direct axial tension, is also seriously impaired. Cold bolts, in holes drilled to a driving fit, with no eccentric bearing, with nuts not too firmly tightened, or a detail in which rivets are used in shear only, should be employed.

In long riveted connections, connecting beams to girders, bolts near the end where there is considerable negative moment would probably do away with the frequent rivet failures. The question even arises whether in very heavy riveted work, where the holes are drilled in the field, where riveting is so expensive, and where the long rivet shanks give so much trouble, snugly fitting bolts would not give greater strength at lesser cost.

JACOB M. FRIEDLAND.

Borough Hall, Bronx, New York, June 12, 1915.

Sir—I think structural engineers of experience will generally sustain the contention that rivets should not be used in direct tension. Rivets, of course, have some direct tensile strength, and no rivet is well set unless it is under an initial stress of that character. The indeterminateness of this initial stress, however, and the difficulty of securing a uniform upset of rivets render uncertain the residual rivet value in direct tension that could be safely relied upon. Rivets are occasionally used in direct tension, but good practice is entirely against it, and if employed at all in that manner their use should be restricted to unimportant connections where failure could result in no serious damage.

All of the authorities of record with which I am familiar discountenance the use of rivets in direct tension, either by definite specification forbidding it or by inference, this latter being indicated by absolute omission of any allowed unit-stress for rivets other than in bearing and in shear. Many of these authorities might be quoted, but the following few will suffice and are characteristic:

Bouscaren's "General Specifications" of 1890, paragraph 85, "No tensile stress shall be allowed on rivets."

Merriman & Jacoby, "Bridge Design," Part III (third edition, 1898), "Specifications for a Pin Truss Bridge," paragraph 39, page 138, "Rivets must not be used in direct tension."

Atchison, Topeka & Santa Fé Ry., specifications of November, 1902, paragraph 89, "The details of riveted work must be so designed that there shall be no tensile stress on rivets."

General specifications for steel highway and electric railway bridge superstructure of the State of New York, 1905, paragraph 88, "Rivets and bolts shall not be used in direct tension."

Ketchum's "Design of Highway Bridges" (first edition, 1909), "General Specifications for Steel Highway Bridges," paragraph 39-a, "Rivets and bolts shall not be used in direct tension."

Cooper's "General Specifications for Steel Highway and Electric Street-Railway Bridges and Viaducts," 1909, "Rivets and bolts must not be used in direct tension."

A slight variation from the foregoing and partially providing for the use of rivets in direct tension is found in the following:

Waddell's "De Pontibus," page 25, points out that the requirement is less important for steel rivets than for iron rivets, but yet advocates adherence to the old rule "except for very unimportant members where there is a great excess in the number of rivets above the theoretical requirements."

"General Specifications for Steel Superstructures of Bridges and Viaducts," Department of Railways and Canals of Canada, 1908, paragraph 226, "Rivets will not be used in direct tension, but in any case where rivets, in direct tension, may be permitted, they shall be estimated at two-thirds of the [illegible] stress."

JOSEPH JACO[illegible]

Seattle, Wash., June 19, 1915.

Sir—Referring to Ernest McCullough's communication in your issue of June 10, I beg leave to quote from my book, "Steel Designing," 1913, as follows:

P. 179. Tension on Rivet Heads.—Specifications usually require that tension on rivet heads must be avoided. As a general proposition this is a good requirement, but there are cases where it is very difficult to avoid tension on rivet heads without making expensive or clumsy details. One expedient resorted to is to use bolts, because a bolt is stronger to resist tension than a rivet. The author prefers rivets in tension, in general, to bolts, for the reason that too often common erection bolts are made use of, and it requires very close inspection to get them tight; and the rivet seals the hole better against the admission of water.

P. 180. Design of Detail to Take Tension on Rivet Heads.—A detail to take tension on rivet heads must be correctly and carefully proportioned. It should be symmetrical. A single angle on one side of a member is not a proper detail. There should be at least four rivets, and these should not be over about 2 in. from the back of angles. In many details where there is tension on the rivet heads the designer does not consider the thickness of the connecting angles. The angles may bend as per Fig. 13.

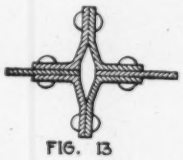


FIG. 13

The thickness of connecting angles must be such as to avoid this. The angle is under bending stress at the heel and at the rivet line, hence the lever arm for bending is half of the gage. For a tensile value on a rivet no more than one-half of the single shear value of the rivet should be used. If 6000 lb. be used as a unit in shear and 10,000 lb. in bending, we find, for $\frac{5}{8}$-in. rivets, 1½-in. gage, 2¼-in. spacing, the thickness of angle required is $\frac{7}{16}$ in.; for ¾-in. rivets, 1¾-in. gage, 2½-in. spacing, the thickness of angle required is ½ in.; for ⅞-in. rivets, 2-in. gage, 2¾-in. spacing, the thickness of angle required is $\frac{5}{8}$ in. The angles should not be any less in thickness than the figures given, and if the gage is more than that given above, the thickness of angle should be increased. Greater spacing of rivets would not be justification for diminished thickness of angles, because the distribution of load along the rivet line is not as good with wide spacing as with close spacing. If the connection angle has two rows of rivets, only the row next to the heel can be counted upon to take tension. It is manifestly impossible to transmit any tension into the second row in a more or less flexible angle until the first row fails. The second row, however, can take any shear in the connection. When there is shear in the connection, the rivets required for the same should be in addition to those required for tension.

Tests have shown that tension on rivets due to cooling is sometimes very high, approaching at times the elastic limit of the steel. This would seem to indicate that any more tension might cause failure; but a little analysis will show that pulling on the head of a rivet already in stress due to shrinkage does not increase the stress on the rivet, but relieves the pressure on the plates, unless the added tension exceeds that already on the rivet.

Under "General Specifications for Structural Steel Work," in the same book, p. 454, occurs the following:

Tension on rivet heads will be allowed only when the connection is symmetrical and contains at least four rivets. The bending at the heel of connection angle must be considered as well as the bending on the part to which the detail is attached. When ⅞-in. rivets are used, the connection angle should be $\frac{5}{8}$-in. metal and the gage of rivets 2 in. With ¾-in. rivets use ½-in. angles and 1¾-in. gage, and with $\frac{5}{8}$-in. rivets use $\frac{7}{16}$-in. angles and 1½-in. gage. Additional rivets must be provided to take any shear coming upon the same connection.

Mr. McCullough invites discussion of this subject. The foregoing is my contribution. Tension on rivet heads always has been and always will be used in designs. It behooves engineers, instead of winking at these details, to take cognizance of the facts and regulate the matter by proper and rational rules. In *Engineering News*, Apr. 11, 1907, I pointed out, among other bad details, a case

of a large viaduct near Pittsburgh where the sidewalk bracket is depending solely on tension on four rivet heads, and this in a lop-sided detail. Furthermore, if these rivets should pull apart the truss would be split and wrecked. The viaduct still stands; but this is no excuse for such details to exist. It does show, however, that rivet heads will stand a very considerable pull.

As to rivet heads that pop off, this could be avoided with proper field inspection on the job. When rivets are taken out of the forge spitting fire and driven in this condition, they are very apt to do just this.

The case of the rail at the switch-joint cited by Mr. McCullough is no doubt one where a rivet or bolt would be bent back and forth each time the load passed. This is a good way to break anything. A wire that would require half a ton in tension to break it can readily be broken off by the hand with an ordinary pair of pliers by bending back and forth. Some years ago the Brooklyn Bridge suspenders carrying a number of the floor-beams gave way. The failure was due to the bending back and forth of these bolts by expansion and contraction of the stiffening truss. The broken suspenders were close to the expansion joint of the stiffening trusses. In such cases as these special provision must be made; but in the ordinary case of structural details tension on rivet heads, properly safeguarded and in proper details, is quite reliable.

EDWARD GODFREY.

Monongahela Bank Building,
Pittsburgh, Penn., June 15, 1915.

Sir—In the June 10 issue of *Engineering News* Ernest McCollough raises the oft-discussed question whether or not rivets should be subjected to direct tension. Specifications generally forbid the use of rivets in tension, and to my mind this is eminently proper.

Changing the shape of the metal in forming a head—an effect often obtained with insufficient heating and improper driving—must result in greatly weakening the rivet at the junction of the shank and the head. The shank shrinks in cooling, putting a considerable stress at this point, and rivet heads coming off "of their own accord" is not an uncommon occurrence. Rivets which may already be stressed from this cause to nearly the point of failure should not have an additional load applied.

I once directed a number of comparatively "green" hands in the partial reconstruction of a steel-frame building. A pneumatic hand-riveter was being used. The man at the riveter would hammer away long after the head had formed—to "make a good job of it," was his expression. I stopped the work for a few moments while I delivered an impromptu lecture on rivets and riveting. At its conclusion, to illustrate my remarks, I picked up a 4-lb. hammer and struck at a rivet-head in a manner perhaps more forceful than elegant. The rivet-head sailed off into space in a way that would have delighted a golfer, and I barely saved myself from falling off the scaffold.

In the light of the present knowledge of the art, I would not subject a rivet to a tensile stress except in very unimportant details.

C. O. SANDSTROM.

Kansas City, Mo., June 17, 1915.

[With most writers and prevailing practice against tension on rivets, the fact must be faced that many instances exist where rivets are exposed to severe tensile stresses, with entire success. Even in railway-bridge floors, where the impact is high, rivets in tension have been used, and no special trouble developed so far as *Engineering News* has been able to learn. Therefore it would be important to cite specific experience to show that rivets in tension are dangerous, or undesirable, or otherwise objectionable.—Editor.]

NOTES AND QUERIES

Steelwork for the Three Radio Towers at Darien, C. Z., the design and erection of which were described in "Engineering News" of June 24, p. 1228, was furnished and erected by the Penn Bridge Co., of Beaver Falls, Penn., instead of by the Pennsylvania Steel Co., as stated in the article.

A Correspondent Desires Information of a specific case where contracts for work have been let on a sliding-scale percentage basis, under which the percentage to be paid by the contractor was varied according to the proportion borne by the final cost to the original estimate for the work. That is to say, the contractor might receive a certain percentage if the final cost were less than the original estimate, and a decreased percentage if the cost were greater.

The Tentative Design for an Activated-Sludge tank at Houston, Tex., shown in Fig. 5 on p. 170 of this issue, has been revised in minor particulars since the original design was made. A telegram from the City Engineer, received after the page containing the drawing had gone to press, gives these revisions as follows:

Have changed plans. Filtros plate lowered until it is level with concrete at bottom of tank, thus eliminating space for accumulation of sludge in bottom of aërating tank. Have put return flow pipe out away from the shelf shown on drawing and eliminated shelf, thus making the sides of aërating tank smooth. Return-flow pipe will be supported by smooth flat bars with axis vertical extending from side to side of aërating tank. Have tested out return flow as designed and it works satisfactorily.

ENGINEERING SCHOOLS

NEW YORK UNIVERSITY—The School of Applied Science is now offering a four-year course in industrial engineering, intended to turn out men who can engage immediately in the business side of engineering work. The requirements for admission will be the same as for other courses in the school. The course aims to superimpose on the fundamentals of engineering, courses in accounting, economics, industrial history, statistics and cost finding, business organization, factory organization and shop management.

WASHINGTON UNIVERSITY—In 1914, as an experiment, the electrical engineering department offered two courses—one of lectures and one of laboratory work. These were intended primarily for St. Louis men connected with the electrical business and to whom a more detailed knowledge of certain phases of electricity would be valuable. These courses proved very popular and within three days after the opening, further registrations had to be refused. For the year 1915-16 it is proposed to offer night courses of a similar nature in a number of other branches. These are general courses in English, economics, political science, history, mathematics, mechanics and physics. There are technical courses in civil, mechanical and electrical engineering, architecture, mathematics, applied mechanics, and physics. Saturday and late afternoon courses, particularly for teachers, are being offered in all departments.

News of the Engineering World

Progress on the Jackson St. Bascule Bridge, Chicago

The erection of the superstructure of the Jackson St. bridge over the Chicago River has been delayed two months by the Chicago strike of steel workers. The condition of the work on July 2 on the west leaf of the bridge is shown in the accompanying view. This is a trunnion bascule bridge with a span of 202 ft. 3¼-in. c. to c. of trunnions, and will have 1310 tons of steel (exclusive of 105 tons for the machinery). About 500 tons are now erected, 350 tons of which are on the west side, as the completion of the foundation on the east side was delayed considerably.

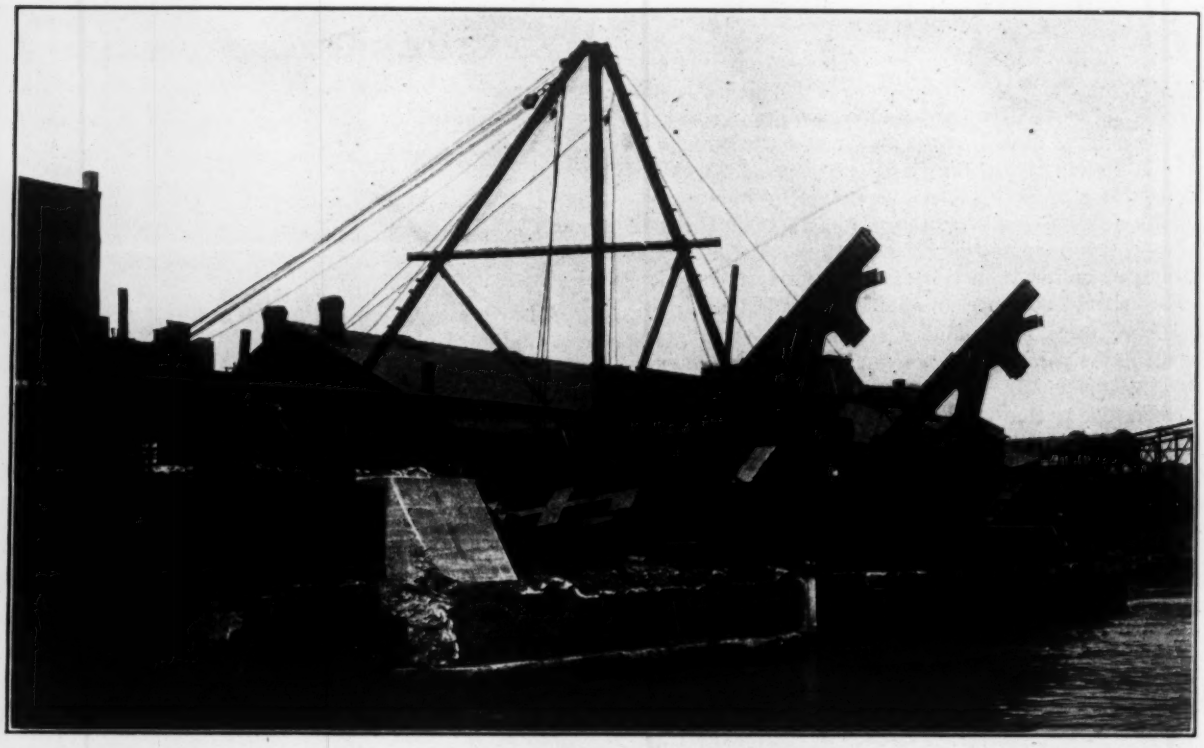
Erection was begun March 12. The strike occurred April 30, stopping all steel bridge and building work in the city until July 7, when a settlement was made and the strike ended.

The view shows the heels of the trusses erected and the trunnions in place. The erection is done by means of a stiff-leg derrick having a 50-ft. mast and a 70-ft. box-lattice boom, with a hoisting capacity of 40 tons. The heaviest loads handled are the 48-ton cross-girders. When the work has advanced farther, a boom 135 ft. long will be used, reducing the hoisting capacity to 20 tons.

The bridge is being built by the Sanitary District of Chicago, under George M. Wisner, Chief Engineer, the plans being approved also by John Ericson, City Engineer. The Strauss Bascule Bridge Co. acts as consulting engineer for both superstructure and substructure. The substructure was described in *Engineering News*, March 18, 1915, and was built by the Great Lakes Dredge & Dock Co. The steelwork is manufactured by the Mt. Vernon Steel Co., of Mt. Vernon, Ohio, and the erection is being done by the Strobel Steel & Construction Co., of Chicago.

First Shield Starts in East River Tunnels

On July 15 at Front St. and Old Slip, New York City, the first of the eight shields of the four new East River tunnels for subway lines started forward, and the first segments of cast-iron lining were erected. The southerly pair of tunnels will carry the Broadway-Church St. line (to be operated by the New York Municipal Ry. Corporation) across the river to a connection with the Fourth Ave. subway; these tunnels are located at South Ferry. The other pair, three blocks north, at Old Slip, will form the river crossing of the



ERECTION OF THE WEST LEAF OF THE JACKSON ST. BASCULE BRIDGE AT CHICAGO (DELAYED BY STEEL-WORKERS' STRIKE FROM APR. 30 TO JULY 7)

At the left is a truss span and deck span of the old approach (over the railway tracks). The girder at the left supports the outer side of a team driveway to the freight house, and spans the opening into the bypass which gives additional waterway for the flow of water in the river. At the right is the Adams St. swingbridge

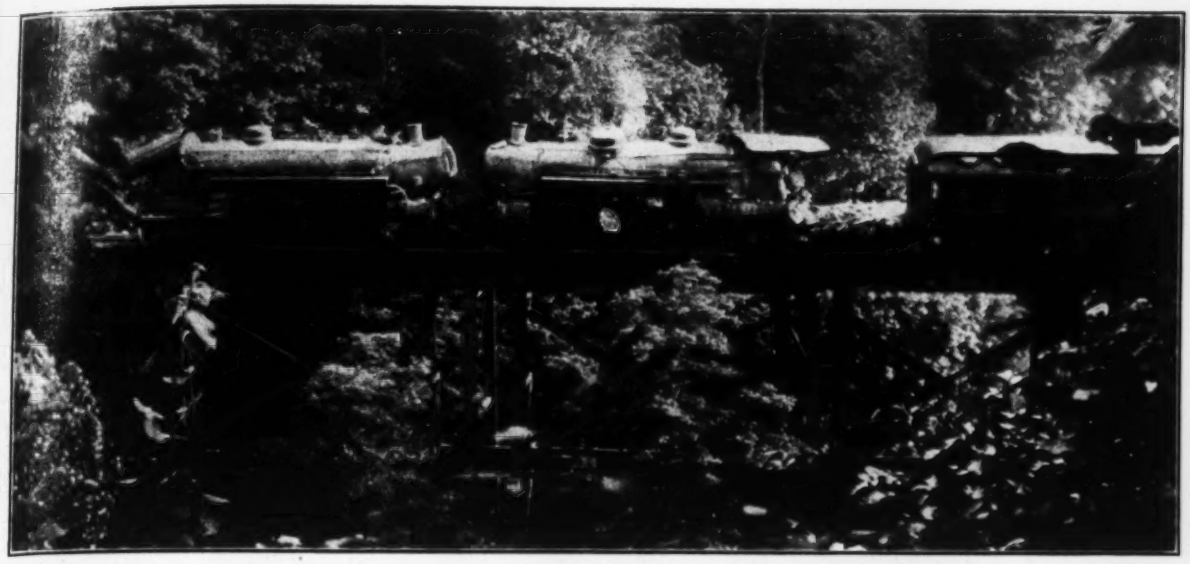


FIG. 1. LOCOMOTIVES TOGETHER ON HIGH BRIDGE

Seventh Ave.-Park Pl.-William St. subway of the Interborough Rapid Transit Co. The Flinn-O'Rourke Co. has the contract for all four. Five caissons have been sunk as land shafts, from which the shields start. In each case a single caisson serves for both tunnels of a pair, except at Old Slip, where the tunnels pass on either side of the Old Slip police station and therefore required separate caissons. The work is managed by George H. Flinn and John F. O'Rourke, of the contracting company.

Investigation of Western Maryland Ry. Wreck; Will Install Block Signals

A searching investigation into the cause of the fatal head collision on the Western Maryland Ry., which occurred on June 24 on High Bridge, near Thurmont, Md., has established that the wreck was caused by an error committed by the Hagerstown dispatcher. This corroborates the opinion voiced in *Engineering News* of July 1. The collision was between the Blue Ridge express and the Baltimore local. Six persons were killed. Property damage is placed at $17,123.

FIG. 2. SHOWING COMPARATIVE HEIGHT OF BRIDGE

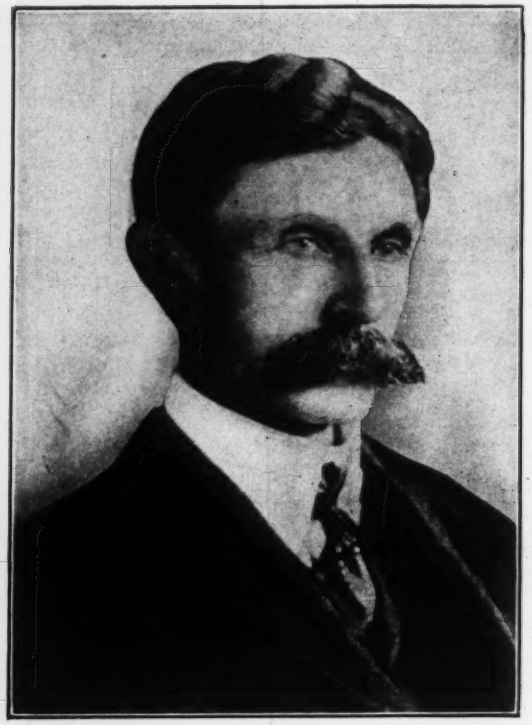
The investigation was in charge of Staunton Ennes, General Manager of the railway. Associated with him were representatives of the Interstate Commerce Commission, members of the Public Utilities Commission of Maryland, and the district attorneys of Frederick and Washington Counties. The Hagerstown dispatcher freely admitted his failure to annul a certain order and accepted full responsibility for the accident. The chief dispatcher in his testimony stated that he believed the mistake was caused by a momentary lapse and not by ignorance on the part of his dispatcher, who claimed to have been overworked.

As a result of the wreck the Western Maryland Ry. Co. will install the block-signal system on 50 mi. of track between Cumberland and Baltimore. It is stated to be the purpose of the company ultimately to equip the entire line with the block-signal system.

San Diego's City Department of Operation

San Diego, Calif., since last May, when the new charter went into effect, has been managed in the main by engineers. The new mayor, Edwin M. Capps, is a member of the American Society of Civil Engineers, and was formerly supervising engineer of city harbor improvements; the manager of operation is F. M. Lockwood, former engineer of the city sewer department, and the assistant manager of operation is John L. Bacon, a member of the American Society of Mechanical Engineers.

The form of city government is similar to the city-manager plan, but, unlike the city manager, the jurisdiction of the head of the city operating department is confined to the following bureaus: Water, sewer, street, harbor, engineering, and public buildings, by the original



JOSEPH AUSTIN HOLMES

charter provision; and the departments of pueblo lands and forestry, building inspection, boiler inspection and electrical inspection by subsequent charter amendment. The operating department has no jurisdiction over the bureaus of public health, purchasing, auditor, treasurer, attorney, city clerk, plumbing inspection, parks, playgrounds or the civil-service commission.

The department of operation, as now organized, pays particular attention to giving full publicity to all the work under its jurisdiction. There is one clerk whose sole duty it is personally to meet any citizen desiring information about the city's business and courteously to give that information as promptly and exactly as possible. A detailed public statement of the financial condition of the city bureaus is made monthly, which gives the various allowances and the percentages expended to date. The appropriations of the operating department for the current year total nearly $600,000.

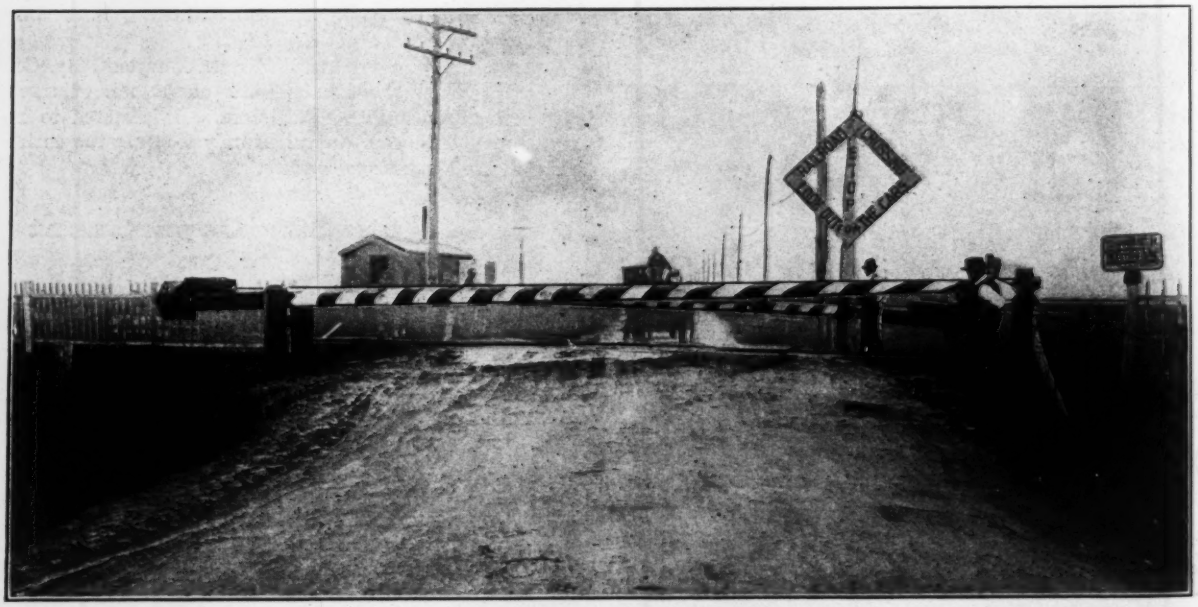
Crossing-Gates which Stop as Well as Warn

Heavy crossing-gates were recently installed by the Long Island R.R. Co. at Long Beach Road near Jekyl Island on the Long Beach division. The purpose of this new type of gate illustrated herewith is effectually to stop adventurous automobilists from trying to beat the train to a crossing.

The gates are constructed of two 40-ft. spruce poles each about 12 in. in diameter on the butt end and 8 in. at the point. They are counterweighted with 1000 lb. of iron and when down are 3 ft. 6 in. above the crown of the highway. They are lowered by means of a ¾-in. rope fastened to the tip of the pole and are kept in place by means of a chain and hook. The gates are about 35 ft. long between posts, with an overhang of 4 ft. The black and white stripes shown are about 12 in. wide.

Joseph Austin Holmes

News of the death of Dr. Joseph A. Holmes was received just as last week's issue was going to press, and space permitted only a brief announcement in the column of obituaries. Dr. Holmes' health failed over a year ago, and he removed with his family to Colorado, hoping to benefit by the change of climate. His system was weakened, however, by overwork, and after his removal to



HEAVY-POLE GATES ON THE LONG ISLAND R.R.

Colorado he continued his oversight of the affairs of his bureau with the aid of a secretary, instead of giving up all business and trying to regain his health.

The news of his untimely death brings sorrow to a wide circle of friends in all parts of the country.

For nearly a dozen years, ever since he was appointed by President Roosevelt to take charge of the fuel-testing work of the United States Geological Survey at the St. Louis Exposition in 1904, Dr. Holmes' enthusiastic devotion to his work has been an inspiring example to all his associates and to many others in the engineering profession who had the privilege of his acquaintance. Probably the greatest achievement of his life was the development of mine-rescue work by the Government, and the scientific investigation of mine accidents with a view to removal of their causes.

It is a notable illustration of Dr. Holmes' zeal and ability that when the Bureau of Mines was created by Congress in 1910, President Taft selected Dr. Holmes to take charge of it, notwithstanding the fact that Dr. Holmes was closely identified with the group of prominent officials in the Department of the Interior against whom the then Secretary of the Interior, R. A. Ballinger, had been in active opposition.

Dr. Holmes was a member of the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Society for Testing Materials, the Cosmos Club of Washington, the Engineers Club of New York City, and a number of other professional and scientific organizations. He is survived by a widow and four children.

Explosion in a Grain Bin of an elevator of the New York Central Lines at West New York, N. J. (opposite 42d St., New York City) partly wrecked the upper portion of the structure and flying fragments slightly injured six persons on nearby barges. It appears that No. 7 of the fourteen 14,000-bu. steel bins was empty when the explosion occurred in it. The supporting steelwork prevented rupture of the bin walls, so that the force of the explosion was exerted upward. The damage was confined to the cupola and main roof, on which the débris fell; the frame and machinery were uninjured. While the cause has not yet been definitely ascertained, it is reported that possibly dust in the bin became ignited by a spark.

A 450-Ton Canal Between the Vistula and the Oder was completed far enough to open traffic in April. The line is 293 km. long. It extends up the Warthe and the Netze rivers, has its summit level for 27 km. in an old canal of originally smaller capacity, and descends the Brahe to the Vistula. The total lift on the east side is 157½ ft. and on the west side 92 ft. The canal can be navigated by vessels of 4-ft. 8-in. draft.

The Los Angeles Municipal Cement Plant has been leased by the city to Los Angeles County. The county is to pay the city an annual rental of $27,500 for a period of three years and at the end of the first year the city may offer the plant in open sale, at which the county agrees to bid $500,000. The city is to have the privilege of buying cement for its own needs in any quantity at $1.35 per barrel and is to receive a royalty if 5¾c. per bbl. on all cement manufactured and an annual depreciation allowance of $11,000, which will be returned to the county in the event of a sale of the plant.

Floods in the Great Miami Valley—Two small floods have occurred in the Great Miami Valley, Ohio, since July 7. The first was caused by a heavy general precipitation over the basin on the afternoon and evening of July 7. The rainfall in the basin varied from 1.30 in. at Hamilton to 3.60 in. at Greenville, with 2.17 in. at Dayton (3½-hr. fall). The flood reached its crest of 11.3 ft. at Dayton about 1 a.m. July 9. The crest of the March, 1913, flood at Dayton was 29.0 ft. The maximum discharge at Dayton at the crest of the flood of July 9, 1915, was about 32,000 sec.ft., from a drainage area of about 2500 sq.mi. The channel at Dayton can carry about 90,000 sec.ft. The discharge in the great 1913 flood was about 250,000 sec.ft. at Dayton. The 1915 flood caused no damage at any of the cities or towns in the valley. Several temporary trestle bridges over the Miami River below Dayton, replacing structures washed out by the 1913 flood, were considerably damaged. The second flood occurred on July 16 at Dayton, where a stage of 7.5 ft. was reached at 8:30 a.m. Little or no damage was caused by this second flood in any part of the valley. The rainfall in the Miami Basin was much lighter than in the preceding flood. In northern and central Ohio, however, this second storm was very severe, and at several points the disastrous flood of March, 1913, was exceeded. At Kenton, on the Scioto River, 5.45 in. of rain fell in 12 hr. on the night of July 15-16. A large portion of the city was overflowed. Foraker, a village near Kenton, also suffered considerable damage. At Lima, where three lives were lost, more than 200 homes submerged and a large area flooded, it is believed that the damage will amount to about $500,000. An estimate places the total losses from this flood in Ohio at over $2,000,000. Ten per cent. of the corn crop of Ohio was destroyed and the wheat crops will be damaged to about the same extent.

The Proposed Navassa Island, W. I., Light Station to be constructed by the Lighthouse Service of the United States Department of Commerce will be located on the southern side of the island, on its highest point, which is about 250 ft. above sea level. The tower will be cylindrical, of reinforced concrete, supporting a cylindrical helical-bar lantern with a focal plane about 152 ft. above its base and 402 ft. above the sea level. The illuminating apparatus will consist of two four-sided, fourth-order lenses mounted side by side, parallel, and carried on a mercury float. The lenses will be provided with 35-mm. mantle lamps. The characteristic will be a double white flash every 30 sec. The range, due to the height of the light, will be about 27 nautical miles. The plans have been completed and bids are to be invited shortly.

A Naval Advisory Committee on Inventions, to comprise the best inventive genius in the United States, has been proposed by Josephus Daniels, Secretary of the Navy. Thomas A. Edison has accepted the chairmanship of this committee. As other members such men as Alexander Graham Bell, Henry Ford, Orville Wright, Lewis Nixon, John Hays Hammond, Jr., Hudson Maxim and C. P. Steinmetz have been suggested. The leading engineering and scientific societies of this country have been asked by Mr. Daniels to select two members each to serve on the committee. The societies thus invited are the American Society of Civil Engineers, American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Chemical Society, American Mathematical Society, American Aëronautical Society and the Inventor's Guild.

The State of Illinois May Purchase Cement for Highways, according to a recent decision of the State Supreme Court. A year ago a taxpayer filed a bill in the Circuit Court of De Kalb County praying the annulment of a certain contract made by and between the State Highway Commissioners and the Marquette Cement Manufacturing Co. on the ground that the commissioners did not have the power to buy cement, which was subsequently furnished to contractors for the construction of state-aid roads. The court ruled:

> We are of the view that the statutes appropriating funds to the commission for the building of state-aid roads, together with the statute giving the commission power to let all contracts for the construction of such roads, or in a certain event to construct the same through its own agencies, and to perform all other duties prescribed in the act or reasonably inferable therefrom, confer upon the commission full and express power to purchase such road building materials, tools, implements and machinery as may from time to time be needed for the purposes aforesaid, and in their discretion to estimate and anticipate the needs and prepare therefor, as the bill here under consideration shows was done, and to the same extent as if the methods of its procedure in the premises were as definitely prescribed as the same are prescribed in relation to letting contracts for highway construction.

A Deep Tunnel Relief Sewer was put under construction by the city of New York last week. The sewer will extend down Madison Ave. from 43rd St. to 41st St. and thence through a rock tunnel from 40 to 45 ft. below the surface, and eastward under 41st St. to the East River, draining the area in the vicinity of the Grand Central Station. A portion of the sewer from the west side of Park Ave., under the existing subway, on to a point slightly beyond Third Ave. will be constructed by the Rapid Transit Subway Construction Co. as part of its contract for the connection between the old subway and the new Lexington Ave. line. The remainder of the work will be done by contractors for the city under the supervision of the Manhattan Bureau of Sewers. Work was started at the site of the proposed shaft at the southeast corner of Lexington Ave. and 41st St. The first shovelful of dirt was turned by Robert Ridgway, Engineer of Subway Construction, Public Service Commission for the First District, after the earth had been loosened by a pick wielded by R. A. Shaler, Tunnel Engineer for the Rapid Transit Subway Construction Co. The cost of the entire work is estimated at $240,000.

PERSONALS

Mr. F. N. Hibbits has resigned as Superintendent of Motive Power of the Lehigh Valley R.R. Co., to accept another position.

Mr. W. Spencer Robertson has been appointed Secretary of the American Locomotive Co., to succeed Mr. C. B. Denny, resigned.

Mr. Carl H. Watson has been selected as Designing and Supervising Engineer of the Port Washington, L. I., Sewer District, lately organized by the Town Board of North Hempstead, L. I.

Mr. George M. Rice has been appointed Chief Engineer of the Puget Sound & Willapa Harbor Ry. Co., to succeed Mr. C. H. Byers, recently resigned. His headquarters will be at Raymond, Wash.

Mr. William T. Dunn, formerly tool-steel expert of the Carpenter Steel Co. in Boston and New England, has been appointed District Sales Agent in New England and Eastern Canada of the International High Speed Steel Co.

Mr. Edward J. Kelly, Assistant Chief Engineer of the Sanitary District of Chicago, has been appointed by Governor Dunne a member of the Illinois Waterway Commission, which is to undertake an 8-ft. waterway from the Chicago drainage canal at Joliet to the Illinois River at La Salle, Ill.

Mr. Joachim G. Glaver, for the last 17 years Chief Engineer of Structural Design and Foundations for D. H. Burnham & Co., has opened offices as consulting engineer, at 751 Railway Exchange Building, Chicago, and will specialize in structural design, foundations and building engineering in general.

Mr. Geo. B. Massey, Jun. Am. Soc. M. E., formerly Manager of Foreign Sales of the Bucyrus Co., at Milwaukee, has opened consulting engineering offices with the firm name of Geo. B. Massey Co., in the People's Gas Building, Chicago. The company will specialize in excavating machinery and methods.

Mr. E. G. Buckland, formerly vice-president and general counsel of the New York, New Haven & Hartford R.R., has been elected President of the Central New England R.R., to fill the vacancy, as required by the law of Massachusetts, caused by the resignation of Mr. Howard Elliott, President of the N. Y., N. H. & H. R.R.

Mr. Henry D. Dewell, Assoc. M. Am. Soc. C. E., formerly with the firm of Galloway & Markwart, San Francisco, Calif., and for the last three years Chief Structural Engineer of the Panama-Pacific International Exposition, has opened offices in the Holbrook Building, 58 Sutter St., San Francisco, for the general practice of civil engineering.

Mr. C. F. Rouze, for the past year Manager of the Kansas City office of the Knox Motors Co., has been appointed Sales Manager of the Knox Motors Associates, of Springfield, Mass., an association recently organized to act as sole distributor of the products of the Knox Motors Co. Mr. Rouze succeeds Mr. H. F. Blanchard, who recently resigned as Sales Manager of the company.

Mr. Charles M. Schwab, M. Am. Soc. M. E., President of the Bethlehem Steel Co., has advised the Pennsylvania State Highway Commission that he will bear a large part of the cost of improving the highways in the vicinity of Loretto, Penn., his birthplace. He has offered to pay 50 per cent. of the cost of construction of two sections of road from Cresson to Ebensburg by way of Loretto, and to build for the latter borough a highway through its center.

Mr. Farley Gannett, Assoc. M. Am. Soc. C. E., Chief Engineer of the Water Supply Commission of Pennsylvania, has resigned to engage in private practice in the City of Harrisburg. Mr. Gannett will specialize in practice before the state departments and commissions. In addition he has established a chemical and bacteriological laboratory to handle analyses of water, sewage and trade wastes. Mr. Gannett has held the position of Chief Engineer for 10 years. He is President of the Engineers' Society of Pennsylvania.

The following promotions and changes have been announced by the Southern Railway: Mr. J. H. Stanfiel, Superintendent of the Southern Railway and the Northern Alabama Ry., at Birmingham, Ala., has been promoted to General Superintendent of the Southern district of the Southern Railway, to succeed C. L. Harris, resigned. Mr. H. H. Vance, Superintendent of Terminals at Birmingham will succeed Mr. Stanfiel. Mr. G. E. Buckley, Engineer of Maintenance-of-Way, at St. Louis, of the Western district, has been appointed Engineer of Maintenance-of-Way of the Northern district, with headquarters at Richmond, Va. Mr. Buckley succeeds Mr. W. T. Dobyns, resigned. Mr. H. E. Tyrrell, Supervising Engineer at Washington, D. C., will succeed Mr. Buckley.

OBITUARY

Charles C. Rose, M. Am. Soc. C. E., Superintendent of the Delaware & Hudson Coal Co., died at his home in Scranton, Penn., on July 17, aged 69 years.

Harold B. Anderson, M. Am. Soc. M. E., Chief Engineer of the Winton Motor Carriage Co., Cleveland, Ohio, was killed in that city on July 13 by a street-car while trying to pass it in an automobile. The accident occurred at the west end of the Superior viaduct. He was 35 years old.

Frank R. Williamson, M. Am. Soc. C. E., Assistant Engineer of the Sanitary District of Chicago, died July 11. He had been in the bridge department of the District for the last six years, engaged principally in the design of bascule bridges. Previously he was Chief Draftsman of the Scherzer Rolling Lift Bridge Co.

E. C. Bower, for 30 years Superintendent of the Waynesburg & Washington R.R., died at his home in Waynesburg, Penn., 66 years of age. He retired from active service on July 1, 1914. Mr. Bower was assistant engineer, under his father, Charles W. Bower, engineer on the flagship "Bridgeport" on the Tennessee River during the Civil War.

Emil Rathenau, probably the best known in America of any of the German engineers, died recently at the age of 76 years. He was Director-General of the Allgemeine Elektrizitäts-Gesellschaft, and was practically founder of the electrical industries of Germany. He was born Dec. 11, 1838, and received his education at the technical high schools of Hanover and Zurich. His first employment was with the locomotive works of A. Borsig in Berlin. Later he was employed in England with John Penn & Son, of Greenwich, and with Easton, Amos & Sons, of London. About 1870 he founded the first telephone exchange in Berlin. He introduced the Edison carbon-filament electric lamp on the Continent and was largely instrumental in establishing the great German electrical works for the manufacture of electric lamps and electrical machinery.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Aug. 16-18 and 25-28. Annual meeting in Los Angeles, Calif., Aug. 16-18; in San Francisco, Aug. 25-28. Secy., J. C. Olsen, Cooper Union, New York City.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 24-27. Annual convention in Cincinnati. Secy., Clarence R. George, Houston, Tex.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 7-9. Convention in New York City. Secy., Willard Kent, Narragansett Pier, R. I.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual meeting in Chicago. Secy., W. O. Thompson, N. Y. C. R.R., East Buffalo, N. Y.

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

San Francisco Meetings

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS.
Aug. 19-21. Secy., E. H. Harman, Room 101, Union Station, St. Louis, Mo.

INSTITUTE OF RADIO ENGINEERS.
Sept. 13-18. Secy., David Sarnoff, 71 Broadway, New York.

PAN-AMERICAN ROAD CONGRESS.
Sept. 13-18. Secy., E. L. Powers, Road Builders Association, 150 Nassau St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 16-18. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Sept. 16-18. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-18. Secy., Bradley Stoughton, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Sept. 16-18. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Sept. 16-18. Secy., J. J. Blackmore, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 16-18. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

INTERNATIONAL IRRIGATION CONGRESS.
Sept. 20-Aug. 1. Secy., Arthur Hooker, Sacramento, Calif.; until Aug. 1, New Stockton, Calif.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Sept. Secy., F. F. Sharpless, 52 Broadway, New York City.

PACIFIC COAST ASSOCIATION OF PORT AUTHORITIES.
Sept. and 21. Secy., Leo V. Merle, Ferry Bldg., San Francisco, Calif.

AMERICAN MINING CONGRESS.
Sept. 20-22. Secy., J. F. Callbreath, Washington, D. C.

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. W. A. Cattell, Secy., Comm. of Management, Fairmont Bldg., San Francisco.

INTERNATIONAL ASSOCIATION OF BRIDGE AND STRUCTURAL IRON WORKERS.
Sept. 20-30. Secy., Harry Jones, American Central Life Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Sept. 21 and 22. Secy., F. M. White, Madison, Wis.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Sept. 23 and 24. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 23 and 24. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN ASSOCIATION OF REFRIGERATION.
Sept. 23 and 24. Secy., J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting. Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27 to 30.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

NATIONAL DRAINAGE CONGRESS.
September, 1915.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

Hollow Building Tile Manufacturers' Association of America—The semi-annual meeting of this association was held in Indianapolis, Ind., at the Hotel Severin, on Tuesday, July 13.

The Northwestern Road Congress will convene in Cedar Rapids, Iowa, Oct. 4-7. The states of Iowa, Illinois, Wisconsin, Indiana, North Dakota, South Dakota, Missouri, Michigan and Minnesota comprise the territory of the congress. The secretary is James P. Keenan, 71 Sentinel Building, Milwaukee, Wis.

Pan-American Scientific Congress—The Second Pan-American Scientific Congress will convene in Washington on Dec. 27, 1915, and conclude its sessions on Jan. 8, 1916. The first congress of this name was held in Santiago, Chile, in 1908. The assistant secretary of the congress is Dr. Glen Levin Swiggett.

American Institute of Chemical Engineers—At the seventh semiannual meeting to be held in Los Angeles (Aug. 16-18), and in San Francisco (Aug. 25-28), the following papers should be of special interest to engineers: "The Improvement of High Boiling Petroleum Oils and the Manufacture of Gasoline as a Byproduct Therefrom by the Action of Aluminum Chloride," "The Purification of Sewage by Aëration in the Presence of Activated Sludge," and "Electrical Precipitation Method."

Texas Good-Roads Association—A joint meeting of the Texas Good-Roads Association and the County Judges and Commissioners Association will be held at the Agricultural and Mechanical College of Texas, Aug. 5-7. Prof. R. L. Morrison, the secretary of the road association, states that practically every road-material company and road-machinery company doing business in the state has arranged for an exhibit at the convention, and that the indications are that it will be the largest and most important road convention ever held in Texas.

American Association of Engineers—This society announces its organization, with headquarters at 29 South La Salle St., Chicago, with W. D. Wilcox, gas engineer, president, and Arthur Kneisel, patent attorney, secretary. According to the constitution, the object of the association is to raise the standard of ethics of the engineering profession and promote its economic and social welfare. The association is to maintain a "service clearing house" for the benefit of its members, furnish patent and legal advice on matters of general interest, and supervise legislation affecting the profession. Applicants for membership must have had at least five years' practical experience in engineering work, or be graduates from recognized technical schools, with at least two years' practical experienec after graduation. The dues are $10 per annum.

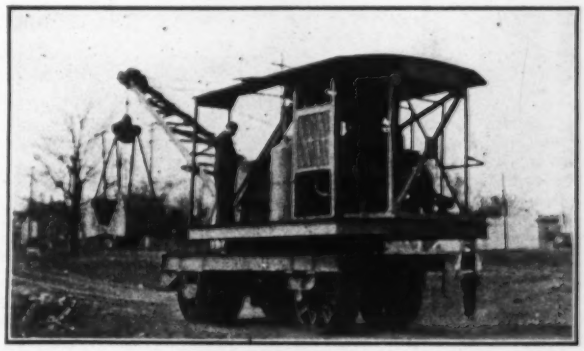
North Carolina Good-Roads Convention—The annual convention of the North Carolina Good-Roads Association occurred in Asheville, N. C., July 14-16, 1915. Sessions were held in the assembly room of the Langren Hotel. More than 200 delegates from all sections of the state were registered. A goodly number of county and township commissioners were present, as well as numerous county, highway and municipal engineers. Two features of interest were noted in the proceedings—the advocacy of state and federal aid for road construction and the emphasis placed on maintenance. Representative Gallatin Roberts, who was instrumental in the enactment of the law creating the North Carolina Highway Commission, spoke in favor of state aid for road building. He said that the state convicts, now used in railroad construction, should be used exclusively for highway work. Congressman J. J. Britt of North Carolina spoke strongly in favor of the Bourne bill, providing for federal aid in road construction. D. H. Winslow, Highway Engineer, United States Office of Public Roads, described methods employed in maintenance work on the Washington-Atlanta National Highway. W. S. Fallis, Highway Engineer of North Carolina, read a paper on the maintenance and repair of macadam roads. Other speakers discussed drainage, grading and maintenance of earth roads. The use of convicts in road construction was also discussed. The last day of the meeting was devoted to an auto trip over the new scenic road through Hickory Nut Gap.—S. H. Lea, City Engineer, Charlotte, N. C.

Appliances and Materials

Tractor-Type Revolving Crane

The revolving crane tractor shown in the accompanying view has been introduced recently by the Davenport Locomotive Works, of Davenport, Iowa, for use on construction work and at railway and material yards. Its main purpose is for handling such bulk material as sand, gravel, stone and coal; unloading it from railway cars at yards or construction switch tracks and loading it (from cars or stock piles) on wagons and motor trucks. It may be equipped also for direct hoisting (as in steel and lumber yards) or for operating a dragline bucket.

The main frame is mounted on 48-in. wheels 24 in. wide, and a differential gear on the rear axle enables the machine to make a turn as short as 25-ft. radius. Caterpillar tracks can be used on machines that are to work on very soft



TRACTOR-TYPE REVOLVING CRANE

ground. The frame carries a cast-steel ring having a track for the rollers of the revolving upper frame and an internal gear or circular rack for the pinion of this upper frame. The legs of the A-frames extend beneath the revolving frame and carry four rollers, which bear against the under side of a flange on the base ring, so that the load on the boom is transmitted directly to the truck and is not carried by the rotating frame or center pin.

The crane may be driven, as shown, by a 45-hp. four-cylinder gasoline engine, by an electric motor or by a two-cylinder vertical steam engine. It is operated by one man, who con-

trols all movements from his platform. The wheelbase is 8 ft. 4 in., with a track width of 8 ft. 6 in. The boom is made 20 to 30 ft. long, with a reach equal to its length and a minimum working radius of 12 ft. The maximum hoisting capacity is 5 tons. The hoisting speed is 150 ft. per min. with a single line, and the swinging can be done at a rate of 3 r.p.m. The traveling speeds are 1¼ and 2½ mi. per hr. The weight of the machine is about 17 tons.

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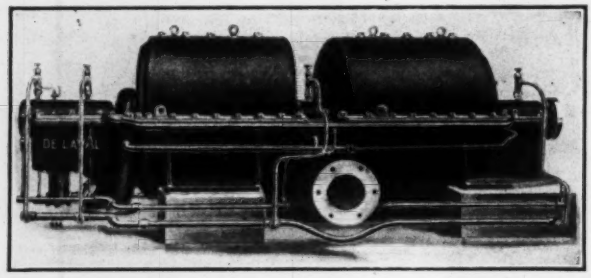
Rotary Air Compressors

A line of high-speed blowers and air compressors, furnishing air at pressure heads of from 4 in. of water up to 120 lb. per sq.in., has been designed by the De Laval Steam Turbine Co., of Trenton, N. J. One of the multi-stage compressor units is shown in the accompanying illustration. The difficulties overcome in getting out this line of apparatus were due largely to suiting materials and practices to very high-speed service. Employment of peripheral velocities of from 450 to 600 ft. per sec. makes pressures of 3 or 4 lb. per sq.in available from single-stage machines.

In the single-stage double-suction blowers, one-piece cast-iron housings carry inlet rings cast integral with a bearing



DE LAVAL CENTRIFUGAL COMPRESSOR

bracket. The housings serve as diffusers and volute passages. The impeller is built up on a chrome-nickel-steel disk thickened at the center to form a hub and to turn the air entering axially. One side of each vane is riveted to this disk and the other to a tapered side plate of the same material. Leakage from the discharge past the impeller is prevented by a labyrinth packing ring. The head-delivery relations can be designed for various services.

The multi-stage compressor casing is split horizontally. The impellers are carried by a large stiff shaft. There are packing rings between the diaphragm and shaft at each stage, a labyrinth packing at the suction end and (for gases other than air) carbon rings at each end of the casing. The stage diaphragms are made separate from the casing and are also split horizontally. When the compressors are water cooled the diaphragms are made hollow. The thrust of all stages is balanced by a cylinder and disk at the discharge end, having one side exposed to suction and the other to discharge pressure. The larger or lower-speed machines are built with two casings and two shafts.

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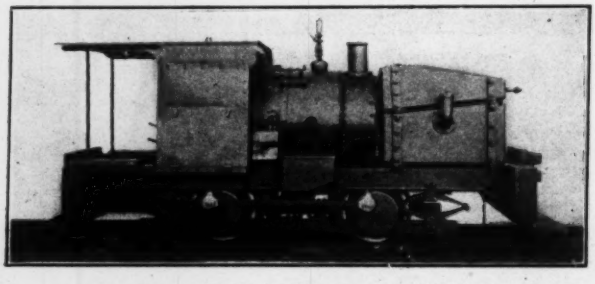
Small Geared Steam Locomotive

A novel type of steam locomotive has recently been designed by the H. K. Porter Co., of Pittsburgh, for use by contractors and industrial railways in competition with gasoline and electric machines. The ordinary direct-connected locomotive when used at low speed, as in switching service and on industrial and contractors' railways, is inefficient because of the very low piston speed. By gearing the engine to the driving wheels, however, this is overcome and it is possible to develop large power with a comparatively small engine.



SMALL PORTER GEARED LOCOMOTIVE

The engine on this locomotive is accurately balanced and by the use of roller bearings, oil-bath lubrication and careful finish of working parts it can run at very high speed, with reliability and without setting up vibration or noising of the locomotive. The boiler is also of special design and is adopted to the use of any liquid fuel. This gives an exhaust free from smoke and sparks. The boiler has a straight shell, long enough to include both the fire-box and the smoke-box, and the copper tubes used are only ½ in. in diameter and about 16 in. long. On a 5-ton locomotive the complete boiler, with fire-box and smoke-box, is only 34 in. in diameter by 37 in. long. The locomotive is built in sizes from 2 to 12 tons for any desired gage of track.

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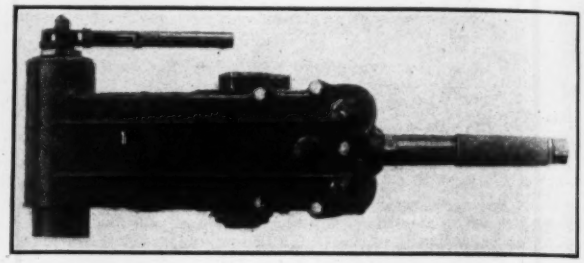
Close-Quarter Air Drill

The air-driven drill shown in the accompanying view has recently been designed by the Ingersoll-Rand Co., of New York City, for shops and foundries, for field work on structural steel, or for any drilling, reaming and tapping in restricted locations. It has been given the trade name of "Little David Close-Quarter Drill."

The distance from end of casting to center of spindle is only 1 5/16 in. It has a three-cylinder air motor running in oil.



PORTABLE PNEUMATIC DRILLING MACHINE

Rotary valves are geared to a three-way crank-shaft turned by ratcheted levers connecting the pistons to the drill spindle. Some one of the three ratchets is always engaged. Loosening a few cap screws gives access to the working parts. The drill is rated for drilling up to 3 in. and for reaming and tapping up to 2 in. It runs at 150 r.p.m.

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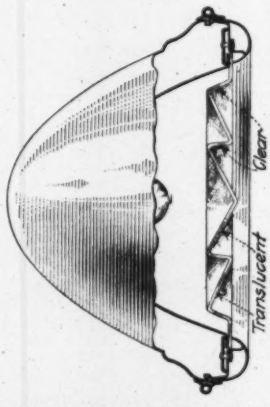
Anti-Glare Headlight Lens

A so-called "safety lens" has been developed by the Lancaster Lens Co., Lancaster, Ohio, to prevent headlight glare. The design for automobile lamps is shown herewith. The "lens" is a plate with circular corrugations and alternate clear and translucent surfaces. It is claimed that only the light thrown out in front is modified, as the reflected beams pass through the clear sections and are distributed as usual.



ANTI-GLARE HEADLIGHT GLASS

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Camp Beds

A simple and efficient bunk for camp, cars, etc., is being put out by the Acme Supply Co., 28 East Jackson Boulevard, Chicago, under the name "Gosso Bed." It consists of a steel-tube frame with a canvas sheet stretched over it and suspended by four chains and springs from ceiling hooks. A spring and chain with tightening lever runs down from each corner to the floor.

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Safety Stop for Crane Hooks

An automatic stop for electric crane hooks has been devised by the Electric Controller & Manufacturing Co., of Cleveland. It consists of a number of contactors mounted in a box and operated by a shaft carrying a sheave over which passes a cable carrying a heavy weight on each end. As the hook reaches the highest point of safe travel a shoulder on the hook engages and raises the lower weight. The contactors are thereby operated so as to open the motor and close the braking circuit. Lowering the hook restores the stop to its former position.

Engineering News

VOLUME 74 JULY 29, 1915 NUMBER 5

Chicago Municipal Pier

An important public work now being carried on by the city of Chicago in connection with its outer-harbor project is the construction of a municipal pier for freight and passenger steamship service, with accommodations for a recreation space and a public hall.

The pier is north of the mouth of the Chicago River, in line with Grand Ave. and Illinois St. It is 3000 ft. long and 292 ft. wide. At the shore end is a headhouse, forming the entrance and having offices on the upper floors. The city or land front of this is shown in Fig. 1. From the rear of this extend two parallel double-deck buildings, 2335 ft. long, for freight and passenger service. These are at the sides and are separated by a central 80-ft. driveway. The remaining 665 ft. is for recreation purposes, with an open upper deck, which forms a shelter for the space below. Near the end of the pier is a municipal hall for public meetings, concerts, etc. The general design is shown by the plan and cross-section (Fig. 2).

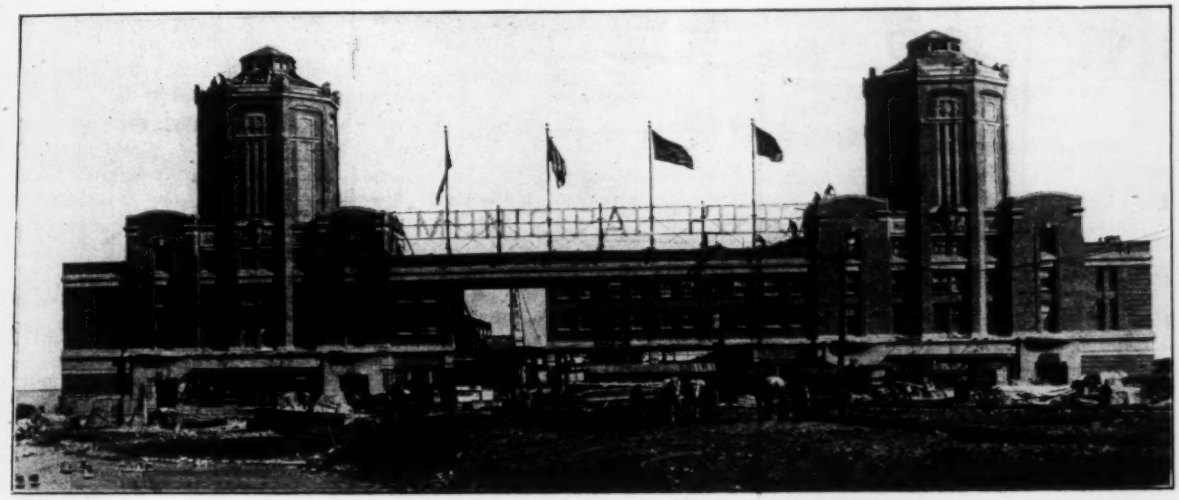

FIG. 1. HEADHOUSE OF THE CHICAGO MUNICIPAL PIER

From the shore or beach to the concrete bulkhead wall on the United States harbor line there is a fill 500 ft. long. This stretches south to the river and will be extended 400 ft. north of the pier to form a park and improve the approach facilities. Two double-track railway lines will be laid along the sides of the driveway adjacent to the sheds. These tracks will connect with the harbor branch of the Chicago & Northwestern Ry. at the street level; but locomotives will be allowed to work them only at night.

A double-track incline will connect the street railways on Grand Ave. and Illinois St. with tracks on the upper deck of the pier. There will be a single track along the inner (or driveway) side of each shed, extending along the recreation deck to a passenger terminal loop and station in the terminal building. One or more intermediate loops across the driveway will make it unnecessary to run all cars the full length of the pier. A concrete walk 8½ ft. wide will be laid between the shed and the track.

The situation is exposed, but protection for vessels in rough weather (and especially in the northeast gales) is provided by the existing outer breakwater of the United States Government. This is about 2500 ft. north of the pier and extends in a northwest direction toward the shore. It is intended to close the present open space by a breakwater extending northeast from the shore to the end of the present breakwater, leaving an opening between them for vessels to pass in and out. An extension of the present breakwater is also to run south from its outer end, with an opening in line with the mouth of the river. These protective works will be undertaken by the United States Government (War Department) as part of the Chicago harbor improvements.

The general construction of the pier is shown in the cross-section (Fig. 2). On each side are three rows of timber piles to carry a massive concrete dock wall, while an outer line of timber sheetpiling retains the fill of mud and sand pumped in by suction dredges. Part of the top fill behind the concrete walls was placed by a dipper dredge. The pier is in water 20 to 27 ft. deep. On the inside of the sheetpiling is a rock fill, which was deposited before the sand, so that the latter would fill all

interstices and make a solid fill. The sheetpiling is reinforced on the outside by loose rock filled against it along the bed of the lake, but not extending high enough to interfere with vessels. This construction was described in *Engineering News*, Sept. 18, 1913.

For the buildings there are pile clusters under the footings of the columns. The freight and passenger sheds have six piles under each outer footing (near the edge of the dock), four for each intermediate footing, and three for each inner footing (along the side of the driveway).

The piles for the concrete walls were cut off below the water line in the usual way, but these for the buildings were cut off about 5 ft. above that line, or at about the level of the top of the filling. Owing to the rough water some trouble was experienced in holding in line the rows of piles which are to carry the dock wall. Each row of piles is tied to the next row behind, and in the outer portion there are tie-rods extending across the entire width of the pier.

The dock walls were built in alternate sections 30 ft. long (105 cu.yd.) with interlocked joints. Forms were set in place upon the piles after the rock filling had been placed, and a sheet of canvas was laid over the surface of the rock and sand fill to prevent leakage of grout from the concrete. All the concrete for these walls was placed by the floating concreting plant illustrated in *Engineering News*, Mar. 18, 1915.

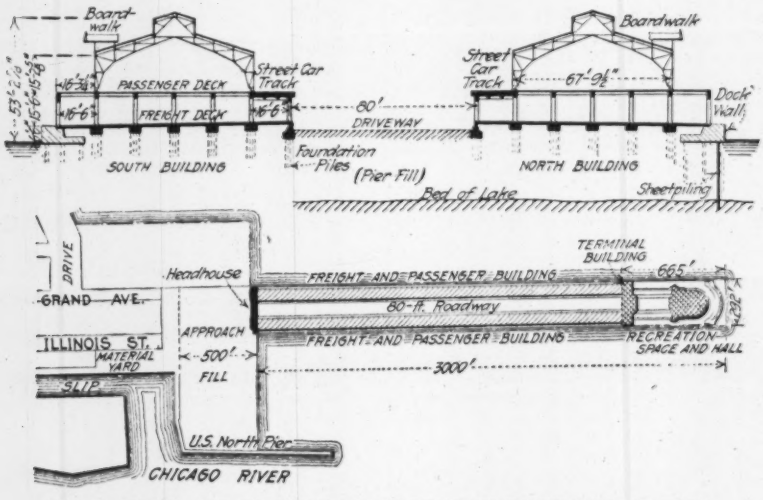

FIG. 2. PLAN AND TYPICAL CROSS-SECTION OF MUNICIPAL PIER

Sand was delivered in open dump scows and broken stone in deck scows. A revolving locomotive crane on the concreting plant delivered the materials to bins over the mixer. The lower part of the concrete was deposited under water by a drop-bottom bucket handled by the crane, but the upper part was delivered in place by spouts or chutes from the elevator tower on the scow.

Freight and Passenger Sheds

The sheds are double-deck structures 100 ft. wide, 6 ft. from the sides of the pier and separated by an open 80-ft. driveway paved with stone and having four railway tracks. The lower deck will be for freight. The upper or passenger deck will be covered for a width of 70 ft. On its water side will be a 16-ft. walk, from which gangplanks will connect with the steamers. On the driveway side will be a 16-ft. open deck with an 8-ft. walk and a single street-car track. To give access to the outer or recreation part of the pier without interference with steamer passengers, a 14-ft. boardwalk is built along the waterfront side of the shed roof. The details of construction are shown in Fig. 3.

The steel framing is in 20-ft. panels longitudinally, while the lower deck has interior columns spaced 16 ft. 6 in. c. to c. The columns are of I-section, built up of four angles and a web plate. These carry the framing of the upper deck, which for the shed floor and outer platform or walk consists of 24-in. I-beam longitudinal girders with 15-in. I-beam joists. The latter are framed between the columns and the girders and are spaced 3 ft. 9 in. c. to c. The framing for the walk and track on the inner side consists of transverse 20-in. I-beam girders between the columns and three lines of I-beam stringers (two under the track). Along the edge of this framing is a 20-in. fascia girder.

The shed roof over the upper deck is supported by three-hinged arch trusses 20 ft. apart. These are of 67-ft. 4-in. span c. to c. of the 4-in. shoe pins, and have a height of 22 ft. 6 in. to the center of the 3-in. crown pin. The shoes are not connected by tie-rods, but the horizontal reaction of the truss (48,000 lb.) is provided for in the joist connections. At the apex is a wide monitor roof, while the chords on the water side carry the framing for the boardwalk. Purlins of I-beams and channels are laid along the chords, and at two panel joints in each side there are kneebraces from the truss verticals to the purlins. Between the inclined portions of the trusses are two lines of longitudinal bracing on each side, and along the vertical backs of the trusses is a double line of heavy channels above the door openings.

The lower floor will be a 10-in. reinforced-concrete slab, with longitudinal girders between the pedestals or footings of the columns. Inside the building it will be paved with 3-in. creosoted wood blocks on a ½-in. sand cushion. The upper deck will be a 5-in. slab resting on the steel frame and having a 1-in. finish. The roof will be a 4-in. slab covered with a pitch-and-gravel composition. Each side of the monitor will be fitted with pivoted sash operated from the floor. The sides on both decks are composed almost entirely of glazed sliding doors and fixed sash, with a small amount of concrete paneling. The lower columns and upper-deck framing will be cased in concrete. The boardwalk will be laid with transverse 3x6-in. planks ⅜ in. apart.

Approach Trestle for Car Tracks

The incline approach connecting the street-car lines with the tracks on the upper deck will begin as a solid fill and continue as a double-track steel trestle having girder spans of 30 ft. on two-column bents. This trestle construction is shown in Fig. 4.

The columns carry 21-in. transverse girders, between which are framed two 24-in. outside girders and a central 30-in. girder. At the middle of the span a 16-in. girder is framed between the longitudinal girders, and between

the main and intermediate transverse girders are framed four lines of 15-in. I-beam stringers, upon which are laid the track ties. Each track has outside guard timbers, and the space between the rails and tracks is covered with longitudinal planking. Each column is composed of a 12-in. I-beam (web parallel to the track) and two 12-in. channels (flanges inward), with bottom plates across the flanges. This structure is designed to carry a load of 80,000 lb. on two car trucks 20 ft. c. to c. The maximum height is about 17 ft., and the incline is on a grade of 2½ per cent.

In front of the headhouse will be a deck or loading platform, where passengers can enter or leave the cars. This has a 6-in. slab floor on 15-in. I-beam framing. Here and on the deck carrying the tracks through the building the track ties are carried by pairs of 9-in. H-beams, as shown. On this deck also is a stub track about 100 ft. long, on which outbound cars can be placed ready for passengers. Beyond this the tracks diverge to the two single tracks along the inner sides of the passenger sheds.

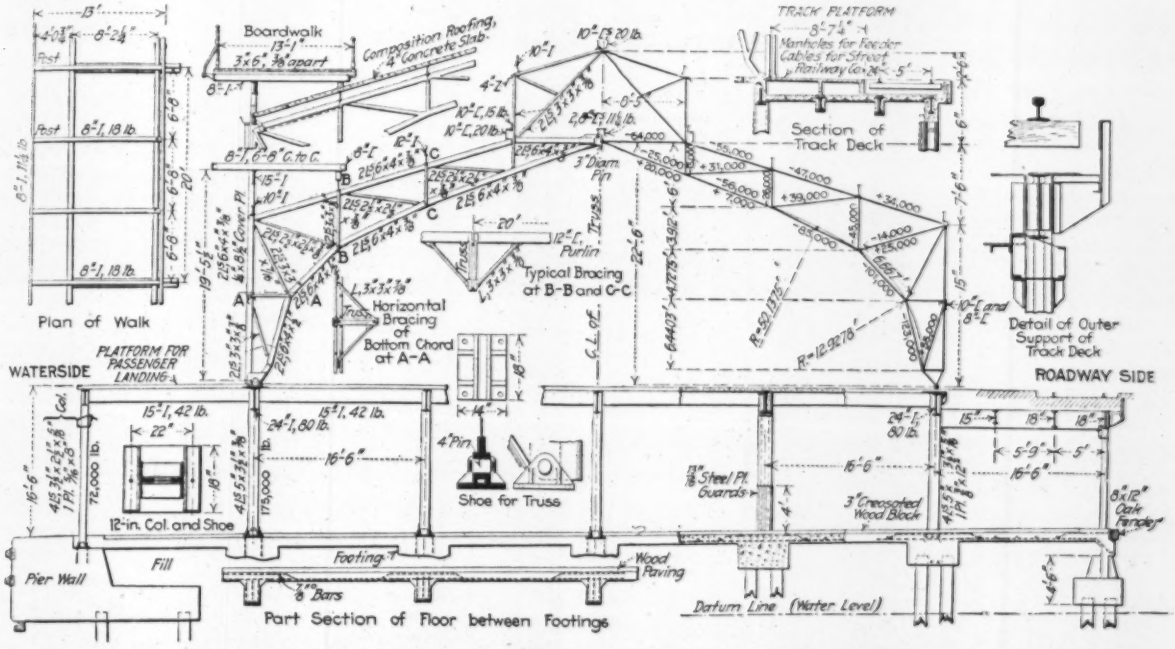

FIG. 3. CROSS-SECTION AND DETAILS; PIER SHED WITH BOARDWALK AND STREET-CAR DECK

Headhouse and Terminal Building

The headhouse (Fig. 1) at the shore end of the pier is of steel-frame construction, incased in concrete and having an exterior finish of brick and concrete which forms the architectural treatment. It is 283x36 ft., three stories high, and has at each end an octagonal tower 100 ft. high, with a 60,000-gal. tank for gravity supply of the sprinkler service. The second floor has toilet and rest rooms and the entrance to the upper (passenger) deck of the steamer sheds. The third floor is utilized for offices. The steel framing presents no unusual features.

At the middle of the building is the entrance to the driveway, with three openings or gateways 26 ft. 8 in. wide. On each side of this is a passenger entrance. A novel and notable feature of the arrangement is the use of winding inclines or ramps instead of stairways to give access to the second floor or passenger deck of the steamer sheds. Experience at some large railway terminals has shown that crowds can be handled more expeditiously and safely on ramps than on stairways. These ramps have a grade of 12 per cent., and are about 12 ft. wide. The concrete floor-slab is 5 in. thick, and crushed granite is used in the 1½-in. top portion to give a wear-resisting surface. The arrangement is shown in Fig. 5.

Access to the third floor (which is not for public use) and to the boardwalk is by stairways. At the second-floor level the double-track street-car line passes through the building, being carried above one of the driveway entrances, as indicated in Fig. 1.

The terminal building is a second transverse structure at the ends of the freight and passenger sheds. It is 283x51 ft., and will contain a restaurant, emergency hospital and public comfort stations. It is of the same general design and construction as the headhouse, but is only two stories high, with triangular roof trusses.

Beyond this will be a recreation space 220 ft. long and 292 ft. wide, covered at the middle by an upper deck or shelter 80 ft. wide, extending between the terminal and recreation buildings. The upper deck will be open. The columns for the shelter deck are of I-section (four 4x4-in. angles on a 10-in. web plate), and are spaced 20 ft. longitudinally and 16 ft. transversely. They carry six lines of 18-in. I-beam girders, with 12-in. I-beam joints spaced 6 ft. 8 in. c. to c. On this will be a 4½-in. concrete slab, with stair-well openings.

Recreation Building

The Recreation Building is at the extreme end of the pier, and its main feature is a great public hall, 140x150 ft., for concerts and entertainments. The floor is about 3 ft. above the main level of the pier for a width of 200 ft.

This hall has three-hinged arch ribs of 136-ft. 8-in. span and 74-ft. 4-in. rise. For the semicircular end of the building there will be radial semi-arch trusses, with their heads attached to a ring girder. In order to provide

against heavy pressure upon this girder, the trusses have cantilever projections on the outer side. These carry the weight of the superstructure and thus balance the half arch. The structural design of this large arched hall is shown in Fig. 6.

The roof will be of 8-in. tile carried by rafters of 6-in. channels on plate-girder purlins, the tops of which extend above the top chords of the arch trusses. Outside of this is a 3-in. layer of cinder concrete, covered with copper. The inner face of the tile will be plastered and finished in a decorative treatment. The towers (157 ft. high) and the exterior walls will be faced brick and terra cotta and given an architectural finish.

The structures, being in an exposed position, are designed for a wind load of 30 lb. per sq.ft.; roofs are designed to sustain a snow load of 25 lb. The floor loads are 250 lb. per sq.ft. for the freight sheds, 200 lb. for the passenger deck, and 100 lb. for the promenades, street-car deck and inclines, and the recreation hall.

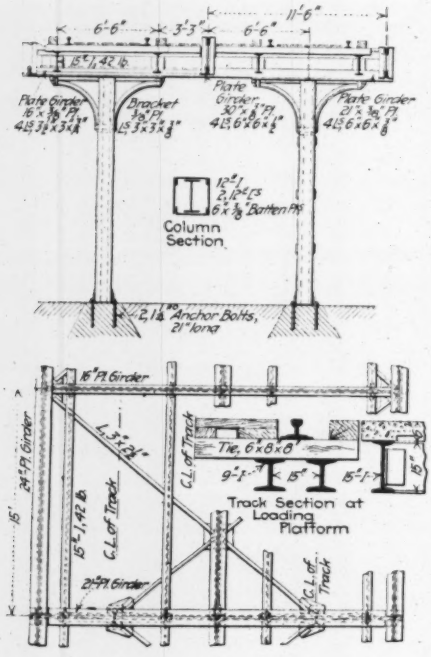

FIG. 4. STEEL VIADUCT FOR STREET-CAR INCLINE

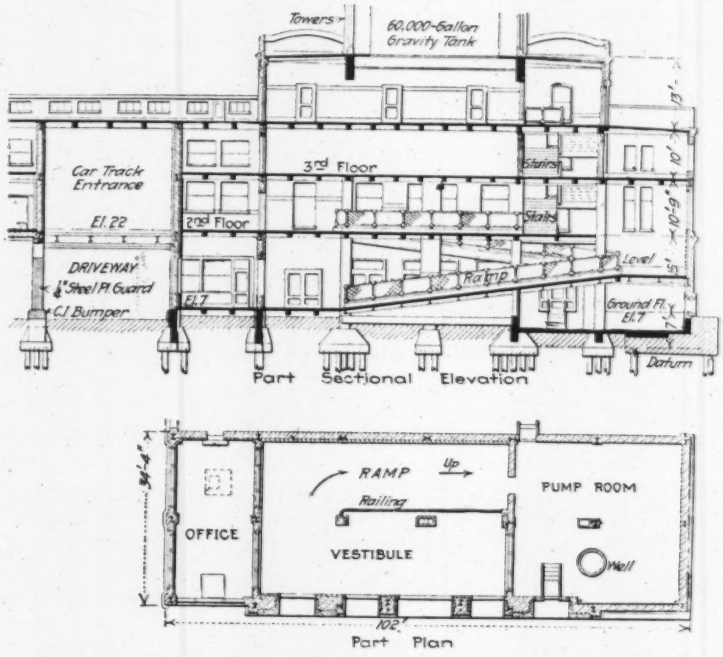

FIG. 5. ELEVATION AND PLAN OF HEADHOUSE

The structural steel was not painted or oiled at the shops. After erection it was given one coat of red-lead and raw linseed oil (25 lb. per gal.) and then two similar white-lead coats. The finishing color will be olive green.

Engineers and Contractors

The pier, with its superstructure and buildings, was designed and built under the direction of the Harbor and Subway Commission, of which E. C. Shankland is Chairman and Chief Engineer, and William Artingstall, Harbor Engineer.

The principal contractors are as follows: Great Lakes Dredge & Dock Co.—foundation piling, $119,900; substructure, $859,869; filling, $200,000; E. L. Scheidenhelm—freight and passenger sheds, $1,091,800; Chaney Archibald Co.—headhouse, $121,757; automatic sprinkler fire-protection equipment, $99,405; John Griffith & Son Co.—terminal building, $129,436; Paschen Brothers—recreation building, $415,000; Ketler-Elliott Erection Co.—steel trestle and incline for street-car connection, $20,700. The total present contracts amount to $3,279,254. The land cost about $300,000, and the total cost of the pier complete, with approaches and superstructure and the water-supply, sewerage, plumbing, and electric-light equipment, will be about $4,000,000.

Criticisms on the Pier Design and Construction

During the execution of the work some criticisms were made, which led to investigations resulting in the approval of the design and construction.

In the first place, complaint was made that the pier was unsafe, due to the bulging of the piling and concrete walls forming the sides. The maximum movement was about 18 in. At the request of the contractors a board of five engineers[1] examined the work. They reported that this minor deformation of the alignment affected the appearance only.

The next complaint was against the interior piles (for footings of buildings) being cut off above the water line. The Commissioner of Public Works appointed a board of three engineers to investigate this.[2]

The report points out that while the general provision is wise, under certain specific conditions (as in this case) it may be ignored with safety. In the fill of the pier the piles will be surrounded by moist clay or sand and protected against air circulation by the pier walls and the concrete floor. The conditions are favorable for piles cut off above water line; and to conform to the building ordinance in order to provide against the remote proba-

[1] W. H. Finley, Chief Engineer, C. & N. W. Ry.; F. M. Graham, Division Engineer, Pennsylvania Lines; and Isham Randolph, H. B. Herr and G. L. Clausen, consulting engineers.

[2] Col. W. V. Judson, U. S. Engineer Corps; R. W. Patterson; and C. H. Cartlidge, Bridge Engineer, Chicago, Burlington & Quincy R. R.

bility of decay of the top of the piles would have caused an increase in cost not warranted by the conditions.

Another criticism from the Building Department was that (under the ordinances) the tensile stress in the reinforcing steel of the concrete should not exceed 11,000 lb. (instead of 16,000 lb. as specified), and that certain of the first-floor girders were of insufficient strength, while the floor might be loaded to 400 lb. per sq.ft. and the foundation pile overloaded. To this it was replied that the steel is specified to comply with the specifications of the American Society for Testing Materials, and that a stress lower than 16,000 lb. is not required in the numerous reinforced-concrete buildings that have been tested and approved by the department.

It was also claimed that in the upper deck (or passenger shed) the exposed steel of the trusses should be fireproofed or the deck divided by firewalls. This deck has a steel frame, concrete floor and roof. It is simply a concourse, and is in the same class with a trainshed, armory or coliseum, in none of which are the steel trusses usually fireproofed or the floors partitioned. The lower (freight) floor is equipped with sprinklers. The buildings have been approved by the insurance interests and the city's fire-prevention bureau.

As to loads on the piles, it is pointed out that the heaviest loads are on those carrying the headhouse, which have been under full load for some time and have shown no settlement. The freight-deck floor was designed for 250-lb. live-load; and to settle the question of its strength a loading test was made by R. W. Hunt & Co., to determine the deflection and settlement in the floors, girders and foundations under a live-load of 750 lb., or three times the designed live-load.

These tests showed a maximum floor deflection of 0.114 and 0.125 in. at two of the ten points of observation (and in most cases it was much less than this), while the allowable deflection is 0.247 in. The deflection in the girder tested was 0.092 in., while the allowable deflection is 0.30 in. With a load of 185.6 tons on one foundation, or 46.4 tons per pile, the settlement after 64 hr. was only 0.17 in.

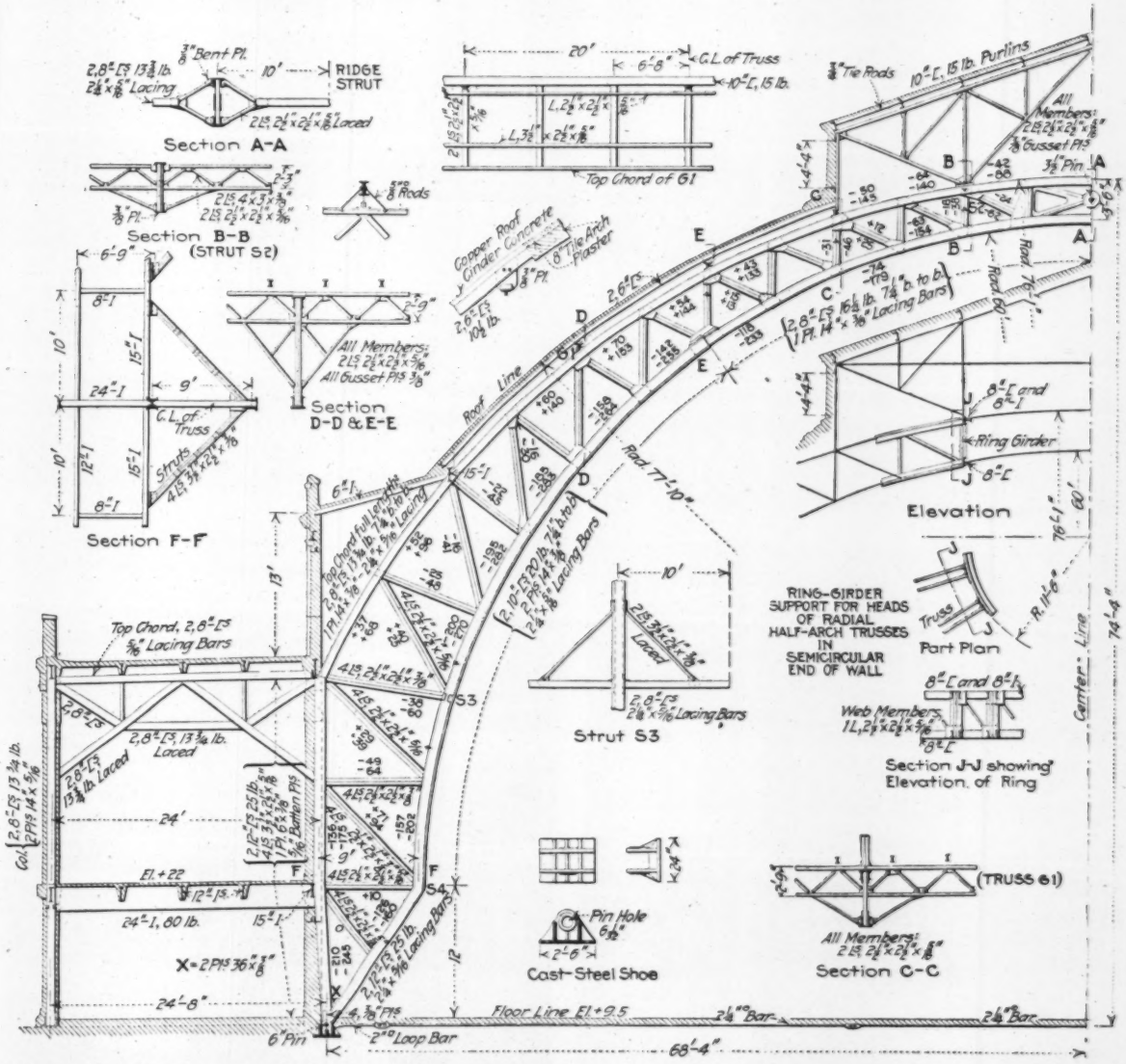

FIG. 6. THREE-HINGED ARCH TRUSSES OF THE RECREATION HALL ON THE MUNICIPAL PIER AT CHICAGO

New Features in Surveying Instruments

The modern engineer's transit is the product of a slow evolution, the elements of which are to be found in the old-time English theodolite and the transit compass invented by William Young, of Philadelphia, in 1831.

For many years most of the improvements were in the direction of more accurate graduation, additional devices, such as the vertical circle, gradienter screw, leveling vial,

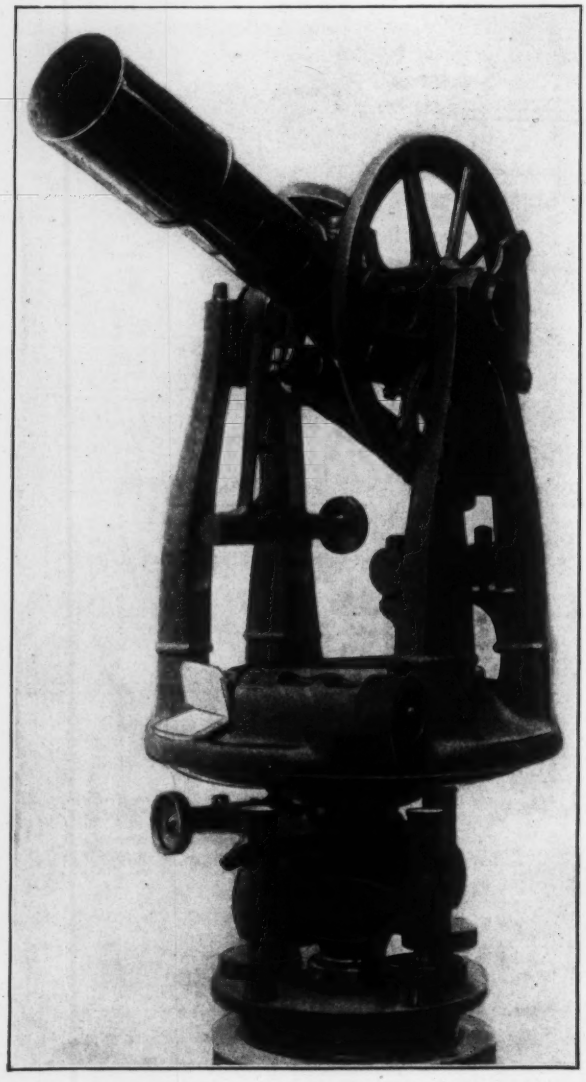

FIG. 1. NEW "MONITOR" TYPE TRANSIT OF EXCEPTIONALLY RUGGED CONSTRUCTION

shifting head, etc.—in short, toward increasing the efficiency and accuracy of the instrument. Recently, however, much of the development has been toward strengthening the structural parts to withstand rough usage, for a good surveying instrument is truly as delicate as a watch, and even with the best care is almost certain to undergo rough handling in preliminary and construction work.

This tendency toward increasing sturdiness is shown in the accompanying illustrations and notes describing a new line of instruments designed and built by C. L. Berger & Sons, Boston, Mass., and known by the trade name of "Monitor." A transit of this type is shown in Fig. 1. In this are embodied several new features, the most striking of which are the exceptionally rugged, strong and rigid standards. The standards are screwed

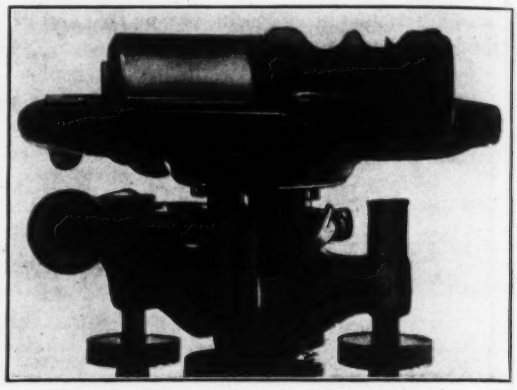

FIG. 2. BUBBLE GUARD FOR TRANSIT

into the plate casting at the ribs, which are seen about an inch above the plate.

The plate casting is reinforced beneath with two stout ribs which serve as continuations of the standards and give additional lateral stability. The plate casting has a pitched roof so as to shed water, and includes a plate-bubble protection as shown. A similar bubble guard, which may be screwed on any transit plate, is shown in Fig. 2. The bubble guard has the additional advantage of preventing inaccuracies resulting from sudden changes of temperature in the bubble, if the sun shines directly upon its mountings. Indeed, a sensitive bubble is appreciably affected if its mountings, on a cold day, come in contact with the fingers, or if the face of the observer is held too close.

The telescope axis has large (½-in.) bearings, with special provision to minimize wear and to make easy necessary adjustments. The screw caps on the ends of the axis are designed to prevent the least side play of

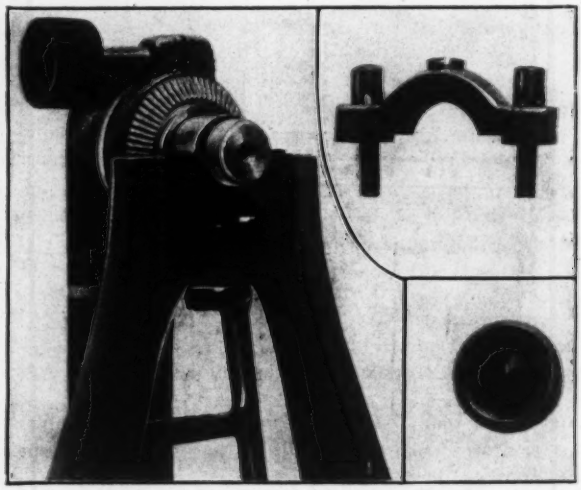

FIG. 3. AXIS DETAIL OF "MONITOR" TRANSIT

the axis and to give additional rigidity to the standards and telescope mounting. Fig. 3 shows a detail of this together with the improved adjustable Y-block, which can be moved in its grooves by opposing capstan-

headed screws. A more than ordinarily stiff aluminum casting is also used to protect the vertical circle.

The leveling head is strongly built of a ribbed casting, with the leveling screws protected throughout their

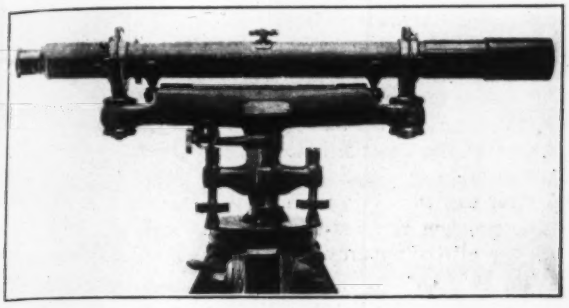

FIG. 4. "MONITOR" TYPE Y-LEVEL, SHOWING BUBBLE PROTECTION

length. The tangent screw and clamp are similarly protected. As will be noted, in the structure of the whole instrument every part, so far as possible, has been given a rounded form, and corners and square edges have been avoided.

A similar method of construction has been followed in the "Monitor"-type levels. Fig. 4 shows a new Y-level, which is noticeably low set and strongly built. The Y-bar is so constructed as to protect the bubble and still allow some lateral movement in making adjustments.

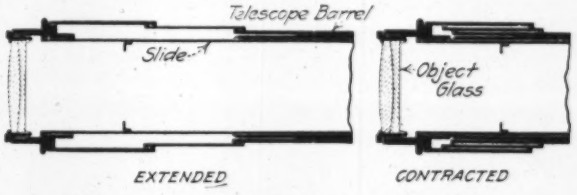

FIG. 5. COLLAPSIBLE-SLEEVE DUST GUARD

To prevent wear on the collars, as well as to secure compactness, the telescope can be revolved on the Y's only between 20° and 30°, but the line of collimation of the telescope may be verified at any time by lifting the telescope out of the Y's and rotating it to 180° in that manner. To more completely protect the bubble from the sun or rain, a piece of thin transparent celluloid may be stuck into the Y-bar casting, forming a complete box to inclose the bubble.

Another new feature is the collapsible dust guard shown in Fig. 5, which protects the object end of the telescope. This works on exactly the same principle as a collapsible drinking cup. Fig. 6 shows the construction

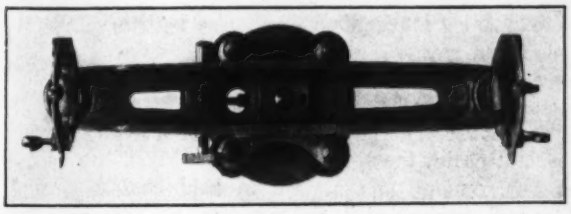

FIG. 6. HOLLOW Y-BAR OF NEW TYPE OF LEVEL

of the hollow Y-bar of the instrument shown in Fig. 4. This type of level was developed largely to meet the specifications of the U. S. Government for a level which would keep its accuracy in spite of rough handling. The mirror shown in Fig. 7 is made detachable and may be fitted to any of the new levels.

The type of dumpy level shown in Figs. 7 and 8 is also strongly built. In this instrument the telescope barrel

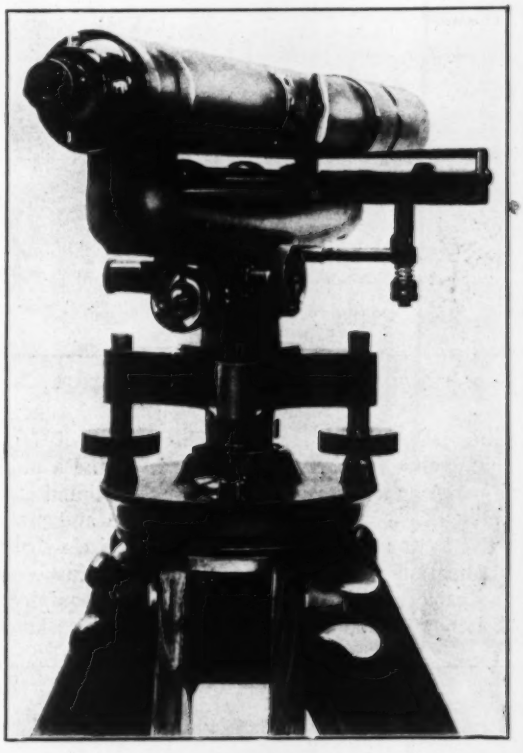

FIG. 7. END VIEW OF Y-LEVEL, SHOWING DETACHABLE MIRROR

and both uprights are cast in one piece. The barrel is bored and not made of drawn tubing. The ribbed cross-bar and instrument center are also cast in one piece. As will be seen from the illustration, the cross-bar is exceptionally long.

Another type of low set Y-level is shown in Fig. 9, and the tubular Y-bar of this level is shown in Fig. 10. This hollow Y-bar incloses the slow-motion screw and clamp, adding both to compactness and neatness; and it is claimed that the free circulation of air through

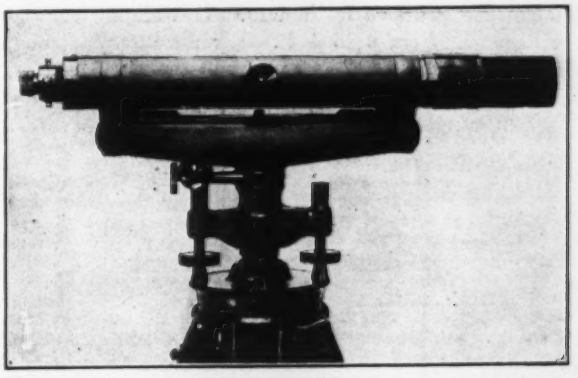

FIG. 8. "MONITOR" TYPE DUMPY LEVEL

and around the bar causes less movement due to temperature changes than with the older style solid bar.

In addition to the structural features described, the new type of transit has graduated circles in which fig-